ONLYIAS
BY PHYSICS WALLAH

UPSC WALLAH

HUMAN AND ECONOMIC GEOGRAPHY

COMPREHENSIVE LEARNING SERIES FOR PRELIMS AND MAINS

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A plethora of UPSC Study Material is available in the market but PW ONLY IAS professionals are continuously working to provide the supreme quality study material for our UPSC students.

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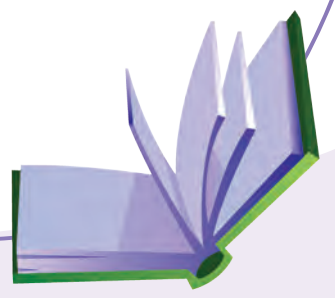
- Holistic coverage of topics, strictly as per exam syllabus
- One-stop solution for subject wise coverage
- Intensive use of Maps, Diagrams, Flowcharts and Timelines for quick understanding and revision
- Thinking Points in and as ‘Ignite Your Mind’
- Updated with latest current affairs and data



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Human and Economic Geography

1

INTRODUCTION

Geography as a discipline provides a **broad and integrated** perspective on both the physical environment and the complex link between the natural world and the human societies spread across it. This field seeks to comprehend the Earth as humanity's home by investigating the factors that support human life. It navigates disagreements regarding its focus, deciding whether to be **descriptive or legislative,** and whether to take a **regional or systemic** approach. The **inseparability of natural and human factors** is an important understanding in geography, which advocates for a holistic perspective.

NATURE OF HUMAN GEOGRAPHY

- Human geography, according to **Ratzel,** is **synthetic study** of the relationship between human societies and earth's surface.
- It investigates the complex interaction between our **physical world** and the **socio-cultural** contexts created by human activity.
- This discipline of geography focuses on human inventions, building on the underlying knowledge of physical factors such as **landforms, climate, and natural vegetation.**
- These constructs include houses, cities, and transportation networks, as well as industries, farms, and ports, all built with natural resources.
- It is a two-way street. While human activities have dramatically altered the physical landscape, the environment has also had a huge impact on human life. Human geography tries to study this interaction with emphasis on humans.

Human geography and physical geography are two main branches of the broader field of geography, each focusing on different aspects of the Earth's surface and its relationship with human activities. Here's a table highlighting some key differences between human geography and physical geography:

Differences between Human Geography and Physical Geography

Dimension	Human Geography	Physical Geography
Focus	Human geography focuses on the study of people, communities, cultures, economies, and their interactions with the environment.	Physical geography is concerned with the study of the Earth's natural environment and processes.
Themes	This branch explores themes such as urban development, population growth, economic activities, cultural systems, political structures, and the impact of humans on the environment.	Key themes include the study of landforms (geomorphology), climates (climatology), water systems (hydrology), the distribution of species (biogeography), and soils (pedology).
Methods	Human geographers often employ qualitative methods, including interviews, ethnographies, and participant observation, as well as quantitative methods like statistical analysis.	Physical geographers typically use scientific and quantitative methods, including field observations, remote sensing, and geographic information systems (GIS).
Subject Matter	The subject matter of human geography revolves around human activities, societies, and their relationship with the environment.	The subject matter of physical geography focuses on the natural environment and physical processes.
Interdisciplinary Nature	Human geography often intersects with fields such as Sociology, Anthropology and Economics.	Physical geography commonly intersects with Environmental sciences, Geology and Meteorology.

IGNITE YOUR MIND

Dubai's indoor ski slopes seem to defy logic. Is this an example of humans bending nature to their will (possibilism), or are we pushing environmental limits too far? Can advanced technology completely overcome environmental limitations, or will nature always have the upper hand? Discuss with real-life examples (e.g., desalination plants, genetically modified crops).

Human-Environment Relationship

The **human-environment interaction** is critical for understanding how geographical elements influence human life, as discussed in **determinism, neo-determinism, and possibilism.** Determinism holds that the environment dictates human behaviour; neo-determinism takes a middle ground in which the environment establishes boundaries but allows for human agency to play its part; and possibilism emphasises human ingenuity in overcoming environmental constraints. These ideas together investigate the various levels of interaction between humans and their environment.

Determinism

- Determinism in **human geography refers to the belief that all occurrences, including human activities, are ultimately determined by forces outside their volition.**
- Some philosophers claim that all behaviour is governed by prior factors, rejecting the concept of free will.
- Determinism is criticised for **oversimplifying** the human-environment link and **minimising** human agency.
- **Example:** The historical development of industrial zones such as **Germany's Ruhr Valley** shows determinism in human geography on a bigger scale. The availability of coal and iron ore deposits influenced the region's growth as an industrial powerhouse.

Schools in Human Geography

Welfare or Humanistic school of thought in human geography was mainly concerned with the different aspects of social well-being of the people. These included aspects such as housing, health and education. Geographers have already introduced a paper as Geography of Social well-being in the Post Graduate curriculum'.

Radical school of thought employed Marxian theory to explain the basic cause of poverty, deprivation and social inequality. Contemporary social problems were related to the development of capitalism.

Behavioural school of thought laid great emphasis on live experience and also on the perception of space by social categories based on ethnicity, race and religion, etc.

Possibilism

- Possibilism in human geography is a theory that **emphasises the importance of human activity over environmental restrictions. Possibilism sees the environment as constraining but not determining human geography.**
- It implies that, **while the natural environment provides certain possibilities or constraints, it is society's culture, technology, and decisions that form a place.**
- This view **arose as a counter to environmental determinism,** arguing that humans are active moderators of their environments rather than passive recipients of environmental forces.
- Possibilism, is frequently criticised for **overemphasising human agency** while undervaluing the importance of environmental circumstances in affecting human behaviour.
- **Example:** Desert agriculture in Israel despite non-suitability of geography. And another excellent example of possibilism is found in Dubai, in the United Arab Emirates. Although snow skiing in the Middle East may seem preposterous, plans are in place to build the longest indoor ski slope in the world in this city, where one ski slope already exists.
  - The devastating impact of impact of hurricanes and fires in the United States, tsunamis in Japan are but a few examples.

Environmental Determinism (Neo-Determinism)

- Environmental determinism, also known **as climatic determinism or geographical determinism, holds that the physical environment, particularly climate and topography, actively determines cultures, economies, and other socioeconomic elements.**
- It is the idea that natural or physical environment shapes and creates cultures; in other words, the environment has a significant influence on human behaviours and decisions, if not dictates them entirely.
- Neo-Determinism, a recent variation, recognises some environmental influence, but only in the context of technological advancement and human decision-making.
- Neo-Determinism is criticised for failing to completely integrate **environmental limitations** with human decision-making.
- **Example:** An example of environmental determinism is the belief that **ancient Greek civilization thrived due to the region's favourable climate and terrain, which reportedly encouraged democracy and philosophy.**

Naturalisation of Humans and Humanization of Nature

Geography investigates the link between humans and their environment, including how technology mediates this interaction and reflects society's cultural development.

- **Naturalisation of Humans:** Initially, humans adapted to nature's forces, a concept known as **environmental determinism.** Determinism denotes that human culture and activities are determined by natural forces, and man has no free will to change them.
- **Humanization of Nature:** As societies advanced, humans began modifying their environment, which led to **"possibilism"**—exploiting nature's opportunities.
  - Possiblist geographers like Lucian Febvre believed that **man can do anything he wants and that nature has no control over man.**
  - **Technological advancements**, from fire discovery to DNA understanding, illustrate the deepening human-environment interaction.

- Human activities have created diverse cultural landscapes, marking the Earth with human imprints.

❑ **Neo Determinism: Griffith Taylor** coined the term **"neo determinism,"** which advocates for harmonious co-existence with nature as a middle ground between environmental determinism and possibilism.

- **Balancing Act:** It emphasizes modifying nature within limits and respecting environmental sustainability to avoid issues like global warming.

Naturalization of Humans in India

The **Bishnoi people in Rajasthan** is a remarkable example of Indian culture. The Bishnois are well-known for their strong commitment to environmental conservation and wildlife protection, which is firmly ingrained in their religious beliefs and rituals. They live in peace with nature, practicing sustainable living and demonstrating a deep regard for all living species. Their dedication is so intense that they frequently risk their lives to safeguard trees and wildlife, publicly opposing deforestation and poaching.

Humanization of Nature in India

Lake Pichola in Udaipur, Rajasthan, is an excellent example of natural humanization in India. This artificial lake, built in 1362 AD and later developed in the 16th century, exemplifies how natural landscapes may be changed to meet aesthetic and functional human demands. Lake Pichola is more than just a tourist destination, as it is surrounded by gorgeous palaces, temples, and gardens, and includes islands such as Jag Mandir and Jag Niwas. It is a celebration of human innovation, combining nature and architecture to create a peaceful, beautiful oasis amid a bustling city.

IGNITE YOUR MIND

Future Forecast: Imagine the Earth in 100 years. How will human activity and technology have shaped the planet? What geographical challenges and opportunities will future generations face?

FIELDS AND SUBFIELDS OF HUMAN GEOGRAPHY

Human geography is a broad science that investigates the complex interactions between humans and their surroundings.

It includes a variety of fields, each of which investigates a distinct facet of human life, such as cultural practices, economic activities, political institutions, demographic dynamics, and environmental issues. This review gives information about these subjects, emphasising their importance and impact on comprehending spatial phenomena.

Cultural Geography

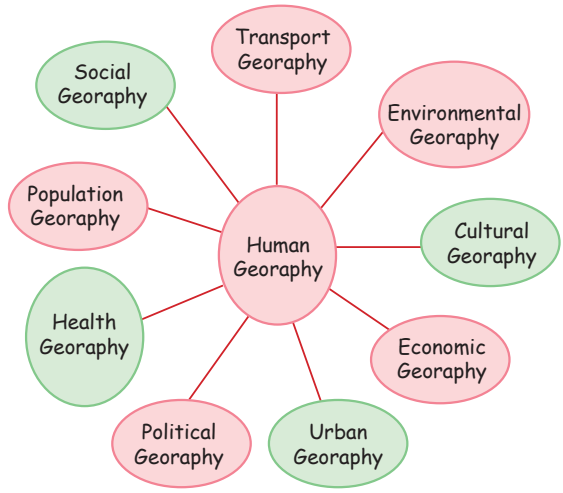


Fig. 1.1: Fields and Sub-fields of Human Geography

❑ **What it studies:** Cultural geography examines the spatial distribution of cultural norms and practices, explores how culture influences and is influenced by landscapes and places.

❑ **Importance:** It provides insights into the complex relationship between societies and their environments, highlights how cultural interactions shape spatial dynamics.

❑ **Scope:** This field covers a range of topics, from traditional cultural practices to contemporary issues like cultural globalisation.

❑ **Significance:** It helps in understanding the impact of globalisation on local cultures and the politics of cultural identity.

❑ **Example:** The study of how local food practices change in response to global food chains is an example of cultural geography.

Economic Geography

❑ **What it studies:** Economic geography is concerned with the spatial aspects of economic activities, and focuses on their location, distribution, and organisation.

❑ **Importance:** This field is crucial for understanding the spatial organisation of economic activities and their impact on regional and global economies.

❑ **Scope:** It includes various subfields like industrial, retail, and agricultural geography.

❑ **Significance:** Recently, it has focused on global supply chains and the geography of the digital economy.

❑ **Example:** An example is the analysis of the location of tech industries in Silicon Valley.

Political Geography

❑ **What it studies:** Political geography investigates the relationship between geography and political phenomena, including territorial boundaries and geopolitics.

- **Importance:** It is essential for understanding how geographical factors influence political decisions and power dynamics.
- **Scope:** The field covers a range from local electoral geographies to international geopolitics.
- **Significance:** Current issues include transnationalism and the geopolitics of climate change.
- **Example:** Studying how natural resources influence territorial disputes serves as an example.

Population Geography

- **What it studies:** Population geography focuses on the spatial distribution of populations, migration patterns, and demographic changes.
- **Importance:** It plays a vital role in planning and managing resources and services in relation to population dynamics.
- **Scope:** This field includes migration trends, urbanisation, and population growth.
- **Significance:** It tackles contemporary issues like migration crises and the challenges of ageing populations.
- **Example:** Analysing urbanisation trends in mega-cities exemplifies this field.

Urban Geography

- **What it Studies:** Urban Geography examines urban areas, their urbanisation processes, and the socio-economic dynamics within cities.
- **Importance:** This field is essential for understanding and managing the complexities of urban spaces.
- **Scope:** It encompasses urban planning, urban sprawl, and the development of smart cities.
- **Significance:** Current trends include sustainable urban development and the study of gentrification.
- **Example:** Researching the impact of smart city technologies on urban living is a relevant example.

Social Geography

- **What it Studies:** Social Geography explores how social processes and structures are spatially organised.
- **Importance:** It aids in understanding the spatial patterns of social phenomena like inequality and exclusion.
- **Scope:** The field covers a range of issues, from community dynamics to global social movements.
- **Significance:** Recent focus includes spatial justice and the influence of social media.
- **Example:** Mapping the geography of social movements such as Black Lives Matter.

Health Geography

- **What it studies:** Health geography analyses the spatial aspects of health and disease, including the impact of environmental factors and healthcare services.
- **Importance:** It is crucial for public health planning and understanding spatial health disparities.
- **Scope:** The field spans from local health service accessibility to global health patterns.
- **Significance:** The current focus includes pandemics and environmental health.
- **Example:** Using spatial analysis to study the spread of COVID-19.

Environmental Geography

- **What it studies:** Environmental geography studies the interactions between humans and the environment, bridging human and physical geography.
- **Importance:** It is key to addressing environmental challenges and promoting sustainability.
- **Scope:** The field includes sustainability, environmental management, and conservation.
- **Significance:** Contemporary issues involve climate change adaptation and environmental justice.
- **Example:** Assessing the impact of deforestation on local ecosystems.

Transport Geography

- **What it studies:** Transport geography focuses on the movement of people, goods, and information and the development of transportation systems.
- **Importance:** It is essential for understanding and improving mobility and infrastructure.
- **Scope:** The field covers everything from local commuting patterns to global logistics.
- **Significance:** Current trends include sustainable transportation and the impact of technology.

IGNITE YOUR MIND

Mountain Madness: Life in the Himalayas is tough. How do the physical limitations of the environment shape the culture and traditions of the people living there? What does it tell us about human resilience?

- **Example:** analysing the efficiency of public transport systems in major cities.

The fields and subfields of human geography provide a complete lens through which we can comprehend the complex geographical features of human existence. They provide crucial insights into a variety of facets of our world, ranging from cultural identities to urban growth and environmental sustainability, highlighting the relevance of geographical study in defining our understanding of and responses to global issues.

ECONOMIC GEOGRAPHY

It is a branch of geography that deals with the **spatial aspects of economic activities.** It encompasses the study of how people earn their living, how livelihood systems vary by area, and how economic activities are spatially interrelated and linked.

Development of Economic Geography

Economic geography has progressed from studying the relationship between **economic activity and the environment**

to analysing complex global and digital economic systems. This evolution includes movements from foundational theories to modern concerns such as globalisation and digitization, demonstrating the dynamic nature of economic spatial organisation.

Location Theories

- **Alfred Weber's theory of industrial location (1909)** was pivotal, analysing how transportation costs and resource availability influence industrial locations.
- **Walter Christaller's Central Place Theory (1933)** further contributed by explaining the spatial distribution of cities and services.

Globalisation and Economic Geography (Late 20th–21st Century)

- **Renewed Focus on Global Interdependence:** Globalisation has had a profound impact on economic geography by emphasising the **interdependence of global economies.** This involves the movement of products, services, capital, and labour across international boundaries.
- **Impact of Global Economic Networks and Multinational Firms:** This research looks into how global economic networks and multi-national firms affect local and global economies. This involves looking into how these institutions affect trade patterns, economic policy, and regional economic development.

Current Dimensions in Economic Geography

- **Digital Economy:** The emergence of the digital economy is a key emphasis in modern economic geography. This includes researching how **digitalization,** or the incorporation of digital technologies into everyday life, is changing economic landscapes, corporate models, and consumer behaviour.
- **Sustainability and Green Economy:** There is an increasing emphasis on sustainable economic development and the **transition to a green economy.** This includes exploring how economic activities can be conducted in environmentally sustainable ways, focusing on renewable energy, sustainable manufacturing, and eco-friendly practices.
- **Global Supply Chains:** The study of global supply chains has become increasingly important, particularly in light of interruptions such as the **COVID-19 pandemic.** This includes understanding the spatial dynamics of how goods are created, moved, and supplied in the global market, as well as how disruptions might affect economies.

Economic geography has evolved into a varied discipline that handles today's global economic concerns, such as digitalization and sustainability. Its ongoing evolution and integration of many perspectives underscore its critical role in comprehending and navigating the ever-changing economic situation.

Scope of Economic Geography

Economic geography investigates the spatial elements of economic activity, with a focus on their distribution, resource utilisation, industrial location, globalisation effects, and regional growth. This discipline provides valuable insights into how geographical considerations influence economic processes.

- **Spatial Distribution:** It involves studying the spatial distribution of economic activities and how they vary from one region to another.
- **Resource Utilisation:** The field examines how natural resources are utilised for economic activities and the environmental impacts of such utilisation.
- **Industrial Location:** A key area of study is the location of industries and the factors influencing industrial location decisions.
- **Globalisation Impact:** Economic Geography also addresses the effects of globalisation on economic activities, including the distribution of industries and the changing nature of international trade and investment.
- **Regional Development:** It encompasses the study of regional development and disparities, focusing on how economic growth and development vary spatially.

Economic geography is critical for comprehending the geographical subtleties of economic activity, ranging from resource utilisation to global trade dynamics. It is critical to creating policies and strategies for long-term development as well as addressing regional imbalances.

IGNITE YOUR MIND

Green Dream: Imagine clean energy is affordable and accessible to all. How would it transform communities, economies, and the environment? What challenges would need to be overcome?

CONCLUSION

Human geography is a broad field that studies the dynamic connections between people and their surroundings. It includes a wide range of topics, including economic geography, which investigates the spatial features of economic activity, and the digital divide, which highlights disparities in technology availability and use. This field is critical for understanding and tackling global concerns like cultural dynamics, urban development, and long-term economic growth.

Water & Land Resources

2

WATER RESOURCE

Introduction:

Water, a finite and vital resource, sustains life and our planet's delicate ecosystem balance. In this chapter, we explore the intricacies of water resources, unravelling their availability, distribution, and challenges for sustainable management. Beyond geographical boundaries, we delve into oceans, rivers, lakes, and aquifers, understanding the dynamic nature of water systems. Amid a growing global population and climate change, the demand for water is intensifying, stressing existing resources This chapter illuminates the interplay between natural processes and human activities, emphasising the delicate equilibrium crucial for water security.

IGNITE YOUR MIND

Privatization Puzzle: Should water be a public good or a private commodity? What are the arguments for and against privatizing water resources?

Types of Water Resource

Water resources are commonly categorised into **three main types** based on their location and availability:

- **Surface Water:**

  Definition: Surface water refers to water bodies that are visible and located on the Earth's surface. This category includes:

  - **Rivers and Streams:** Flowing bodies of water that often originate in mountains or hills and flow towards oceans or seas.
  - **Lakes and Reservoirs:** Standing bodies of water, with lakes being natural and reservoirs typically formed by damming rivers for various purposes.
  - **Ponds: Small, shallow bodies of water**, often man-made but can also occur naturally.

- **Groundwater**

  Definition: Groundwater is water that resides beneath the Earth's surface in permeable rock formations known as aquifers.

  - **Aquifers:** Underground reservoirs that store and transmit groundwater.

- **Atmospheric Water:**

  Definition: Atmospheric water refers to water in the form of vapour present in the Earth's atmosphere.

  - Water Vapour is the gaseous state of water which falls on earth's surface after condensation in the form of rain and snow etc.

Understanding the intricacies of these three types of water sources is crucial for effective water resource management. Balancing the utilisation of surface water and groundwater while considering the role of atmospheric water in the water cycle is essential for ensuring sustainability, resilience, and equitable access to this resource.

Distribution of Water Resources in the World

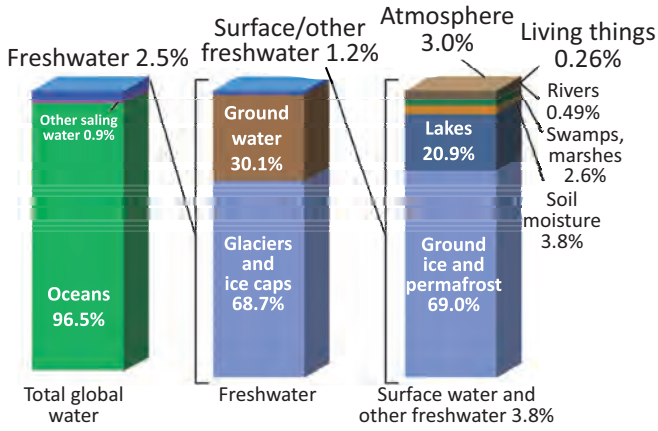


Fig. 2.1: Distribution of Water on Earth

The way water is spread across the Earth's surface is vital in hydrography and broader earth sciences.

- This complex arrangement includes oceans, fresh-water bodies, rivers, polar ice caps, groundwater etc.
- Grasping this distribution is essential for studying environmental processes, climate patterns, and supporting life on our planet.
- Most of our planet's water, around **71%**, is in the oceans. The rest is freshwater, stored in glaciers, underground, in lakes, soil, air, rivers, and within living things. Nearly 59% of the water that falls on land goes back to the atmosphere through evaporation, The rest either flows on the ground, soaks into the earth, "forms glaciers or becomes part of organic matter".

Continent-wise Distribution of Water

- At the continental level on an average America has the largest share of the world's total freshwater resources with 45%, followed by Asia (28%), Europe (16%), and Africa (9%)
  - Water resources are also unevenly distributed across continents.
  - **Antartica:** It alone contains around 70 % of the world fresh water.
  - **Asia:** Holds the largest share with abundant freshwater reserves in rivers and lakes.
  - **Africa:** Faces challenges, with some regions experiencing water scarcity.

- **North America and Europe:** Generally have reliable water access.
- **South America:** Boasts extensive river systems.
- **Australia:** Encounters variability, grappling with arid regions and periodic droughts.

IGNITE YOUR MIND

Watery World: Imagine Earth's water was evenly distributed. How would your daily life be different? What challenges might arise in different regions due to excess or lack of water?

Continent-wise Major Water Resources

Different continents feature varied water resources, including extensive river systems, vast lakes, and glaciers.

Africa:

- **Rivers:** The Nile is the longest river in Africa, running through multiple countries. Other significant rivers include the Congo, Niger, and Zambezi.
- **Lakes:** Lake Victoria, Lake Tanganyika, and Lake Chad are some of the largest lakes in Africa.
- **Glaciers:** Africa has very few glaciers, with Mount Kilimanjaro in Tanzania having some small ice caps.
- **Aquifers:** Nubian sandstone aquifer system located in Sahara desert is largest fossil water aquifer system. Aquifers in Africa are estimated to contain around 20 times more water than the all lakes combined in Africa.

Asia:

- **Rivers:** The Yangtze and Yellow River in China, the Ganges and Brahmaputra in India and Bangladesh, and the Mekong in Southeast Asia are major rivers.
- **Lakes:** The Caspian Sea, although often considered a saltwater lake, is the largest lake of the world. Other notable lakes include the Baikal in Russia and the Aral Sea (though it has significantly diminished in size).
- **Glaciers:** The Himalayan region, shared by several countries including India, Nepal, Bhutan, and China, contains numerous glaciers like Siachin, Baltoro, Biafo etc.

North America:

- **Rivers:** The Mississippi-Missouri system is the longest river system in North America. Other significant rivers include the Colorado, Yukon, and Mackenzie.
- **Lakes:** The Great Lakes (Superior, Michigan, Huron, Erie, and Ontario) are the largest group of freshwater lakes in the world.
- **Glaciers:** Glaciers in North America are primarily found in Alaska and parts of Canada.

South America:

- **Rivers:** The Amazon River is the second-longest river in the world and the largest by discharge. Other important rivers include the Paraná and Orinoco.
- **Lakes:** Lake Titicaca, situated on the border of Bolivia and Peru, is one of the highest navigable lakes in the world.
- **Glaciers:** The Andes mountain range in South America has several glaciers, with regions like Patagonia in Argentina and Chile hosting significant glacial areas.

Europe:

- **Rivers:** The Danube, Volga, and Rhine are major rivers in Europe.
- **Lakes:** Lake Ladoga and Lake Onega in Russia, Lake Geneva in Switzerland/France, and Lake Balaton in Hungary are some of the notable lakes.
- **Glaciers:** Glaciers in Europe are primarily found in the Alps, including regions in Switzerland, Austria, and France and in Scandinavian countries.

Australia:

- **Rivers:** The Murray-Darling River system is the largest in Australia. Other significant rivers include Cooper Creek, Paroo river etc.
- **Lakes:** Lake Eyre is the largest lake in Australia when filled. Other notable lakes include Lake Torrens and Lake Gairdner.
- **Glaciers:** Franz Josef, Fox, Volta, Tasman etc are some of the major glaciers most of which are located in New Zealand and there are no glaciers on Australia as country.
- **Aquifer:** The Great Artisan Basin of Australia is largest and deepest Artisan basin in the world underlying about one-fifth of Australia.

Antarctica:

- **Glaciers:** Antarctica is covered by a vast ice sheet containing about 60% of the world's fresh water, but these are not considered glaciers in the traditional sense.

Arctic:

- **Glaciers:** The Arctic region has numerous glaciers, especially in Greenland and parts of Canada and Russia. The Arctic Ocean itself contains a significant amount of sea ice.

Distribution of Water Resources in India

- India accounts for about **2.45 per cent** of the world's surface area, **4 percent** of the world's water resources and about **17.76 percent** of the world's population. The total water available from precipitation in the country in a year is about 4,000 cubic km.
- The availability from surface water and replenishable groundwater is 1,869 cubic km. Out of this, **only 60 per cent** can be put to beneficial uses. Thus, the total utilisable water resource in the country is only 1,122 cubic km.

Surface Water Resources of India

There are **four** major sources of surface water. These are **rivers**, **lakes**, **ponds and tanks**.

- **Rivers:** In the country, there are about 10,360 rivers and their tributaries longer than 1.6 km each.
  - The mean **annual flow** in all the river basins in India is estimated to be 1,869 cubic km. However, due to topographical, hydrological and other constraints, only.
  - About 690 cubic km (32 per cent) of the available surface water can be utilised.
  - Water flow in a river depends on the size of its catchment area or river basin and rainfall within its catchment area.

Water Resources Stats	
Rainfall Variation	100 mm in the west to 11,000 mm in the east.
Major River Basins (CA >20000 sq. km.)	12 basins, total CA 25.3 lakh sq. km.
Medium River Basins (2000 Sq.Km. < CA <20000 sq. km.)	46 basins, total CA 2.5 lakh sq. km.(CA=Catchment Area)
Navigable River Length	About 14,500 km.
Average Annual Rainfall (1965-2015)	1105 mm (3880 Billion cubic meter)
Annual Rainfall (2020)	1283 mm
Mean Annual Natural runoff	1999.2 BCM
Total Utilisable Water	1122 BCM
Estimated Utilisable Surface Water Potential	690 BCM
Total Replenishatile Ground Water Resources (2013)	432.5 BCM
Net Ground Water Availability (2013)	411 BCM
Ultimate Irrigation Potential	139 Mha
From Surface Water	76 Mha
From Ground Water	64 Mha
Storage Available Due to Completed Major & Medium Projects including Live Capacity less than 10 M. Cum	253 BCM
Estimated Additional Likely Live Storage Available due to Projects Under Construction/ Consideration	155 BCM

- Almost 60 percent of India's renewable water is in the Ganges and Brahmaputra Basins. However, only 37 percent of the water is exploitable.
- High volume and rapid flows into the Bay of Bengal during the summer monsoons are hard to store and almost none of the flow in the Brahmaputra Basin is considered usable.
- The Indus Basin does not contribute much to India's total renewable water supply, but its flows are critical to downstream water users in Pakistan. Many rivers within the Indus Basin are seasonal and terminate in seasonal salt marshes called the Rann of Kutch in the Thar Desert.
- The Western Ghats coastal mountain range form the upper catchments of numerous river basins, including the Krishna and Godavari Basins, which provide 10 percent of India's renewable water.

❑ **Lakes and Lagoons:** Due to its extensive coastline, India is home to a diverse range of lakes and lagoons.

- India has over 1,000 large and medium-sized lakes and reservoirs. Large surface water resources can be found in these lakes and lagoons in states like West Bengal, Kerala, and Odisha.

- Surface water in India is divided 22 basins. The Ganges, Indus, Godavari, and Brahmaputra Basins cover more than half the country.
- The Ganges and Brahmaputra Basins have headwaters in the Himalayas and are part of the transboundary Ganges-Brahmaputra-Meghna Basin which outlets through the Ganges Delta.

Fig. 2.2: Major River Basins of India

Fig. 2.3: Lakes in India

- The largest freshwater reservoirs are the Shivaji Sagar, Indira Sagar, and Sardar Sarovar. Prominent brackish lakes include the Vembanad, Chilika, and Pangong.
- The major freshwater lakes of India include Loktak (Manipur), Wular and Dal (Jammu & Kashmir).

Major Lakes with Unique Characteristics	
Lake	**Unique Characteristics / Records**
Baikal (Russia)	Oldest existing freshwater lake on earth and deepest continental body of water (1620 meters)
Lake Superior	Largest freshwater lake by surface area in the world
Caspian Sea	Largest lake in the world.
Dead Sea	lowest lake.
Victoria	• **Location:** Uganda, Tanzania, Kenya • Largest lake in Africa.
Huron	• **Location:** North America • Second largest of the Great Lakes
Tanganyika	• **Location:** Tanzania, Democratic Republic of Congo, Zambia, Burundi • Longest lake in the world and second deepest after lake baikal
Aral Sea	• **Location:** Kazakhstan, Uzbekistan • Significant lake in Central Asia, shrinking due to irrigation diversion
Ladoga	• **Location:** Russia • Largest lake in Europe
Balkash	• **Location:** Kazakhstan • Shallow salt lake fed by the River Ili, shrinking due to irrigation
Wular Lake	Largest freshwater lake in India - Jammu and Kashmir.

Chilka Lake	Largest Saline water lake in India - Orissa.
Cholamu Lake	Highest lake in India (Altitude) - Sikkim.
Vembanad Lake	Longest Lake in India - Kerala.
Lonar Lake	Meteoric Impact Lake in Maharashtra
Govind Vallabh Pant Sagar (Rihand Dam)	Largest Artificial Lake in India by volume
Dhebar Lake	India's second largest artificial lake by volume-Rajasthan.

Groundwater Resources of India

- The **total replenishable groundwater resources** in India amount to approximately 449.08 billion cubic kilometer (BCM) according to Dynamic Ground Water Resources Assessment.
- High levels of **groundwater utilization** are observed in river basins, particularly in the north-western region and parts of south India.
- **Dynamic Ground Water Resources Assessment (2023):** The assessment covers a total of 6553 units, including Blocks, Taluks, Mandals, Districts, Firkas, and Valleys.
  - Categories based on assessment results:
    - **'Over-exploited':** 736 (11.2%).
    - **'Critical':** 199 (3%).
    - **'Semi-critical':** 698 (10.7%).
    - **'Saline':** 127 (1.9%).
    - **'Safe':** 4793 (73.14%)
- **National Aquifer Mapping and Management (NAQUIM) Programme**
  - Initiated by the **Central Ground Water Board (CGWB)** under the Ground Water Management and Regulation Plan Scheme (XII plan) in 2012.
  - It stands as one of the **largest global endeavors** of its kind.
- **Atlas on Aquifer Systems of India:** Released by the **Central Ground Water Board (CGWB)**, this atlas provides detailed data on 14 principal aquifers and 42 major aquifers.
- **"Ground Water Resources Assessment 2004 to 2023:**
  - Annual Ground Water Recharge (bcm): 433 (2004), 447 (2013), 449 (2023)
  - Annual Extractable Ground Water Resource (bcm): 399 (2004), 411 (2013), 407 (2023)
  - Annual Ground Water Spacing for Irrigation, Domestic & Industrial Uses (bcm): 231 (2004), 253 (2013), 241 (2023)
  - Stage of Ground Water Extraction (%): 58% (2004), 62% (2013), 59% (2023)

Major Central Level Water Institutions Responsible for Ground Water Management

Institution	Role
Central Water Commission	Initiating and coordinating schemes for the conservation and utilisation of water resources in the country in collaboration with state governments; and monitoring water quality
Central Ground Water Board	Developing and disseminating technology related to sustainable use of ground water, monitoring and implementing policies for the sustainable management of ground water resources; estimating ground water resources
Central Pollution Control Board	Implementation of the Water (Prevention and Control of Pollution) Act, 1974 which seeks to restore water quality regulatory directives

Changing Per Capita Ground Water Availability

- The per capita water availability is constantly falling in India. Currently it is below 30% of 1950 level. Based on the study titled "Reassessment of Water Availability in India using Space Inputs, 2019" conducted by Central Water Commission, the average annual per capita water availability for year 2021 and 2031 has been assessed as 1486 cubic meter and 1367 cubic meter respectively. Annual per-capita water availability of less than 1700 cubic meter is considered as water stressed condition whereas annual per-capita water availability below 1000 cubic meters is considered as a water scarcity condition.
- Thus India holds 4% of global water resources, with approximately 4000 BCM. Divided into 22 basins, the Ganges and Brahmaputra contribute significantly. Replenishable Groundwater resources total 432 Bcm (long term average) with latest assessments showing it to reach 449 bcm, with varied utilisation.

India's Per Capita Annual Water Availability cu.m/capita/year

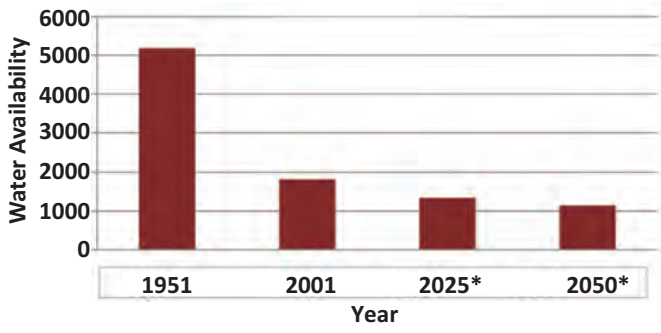


Fig. 2.4: India's Per Capita Annual Water Availability

Significance of Water Resource

- **Essential for Life:** Water is fundamental for all living organisms, playing a vital role in cellular processes and biological functions.
- **Agricultural and Food Production:** Indispensable for agriculture, supporting crop growth and livestock. Globally, 69% of freshwater used for agriculture (FAO). FAO estimates 2,000 to 5,000 liters of water needed daily per person for food.
- **Biodiversity and Ecosystems:** Aquatic ecosystems rely on stable water conditions. About 20% of the world's freshwater species at risk of extinction due to water scarcity and pollution (WRI, 2023).

- **Climate Regulation:** Water crucial for regulating climate through processes like evaporation and precipitation. Changes in water availability can affect regional climate patterns (WRI).
- **Industrial and Economic Activities:** Many industries depend on water for manufacturing, energy production, and cooling. Global water demand may exceed 60% of available resources by 2040 (WRI). Water scarcity can disrupt industrial production, with potential losses up to 6% of India's GDP by 2050 (WRI).
- **Human Health and Sanitation:** Access to clean water vital for human health. Waterborne diseases cause about 425,000 deaths per year (WHO). Over 2.1 billion people live in areas of high water stress, and about 600 million lack access to safe drinking water in India (UNEP, NITI Aayog).
- **Recreation and Aesthetics:** Water bodies offer recreational opportunities. Economic value of the world's water resources for recreation and tourism is about $6.6 trillion per year (WRI). Tourism in India generates about 7% of GDP, with water bodies playing a significant role (NITI Aayog).
- **Hydropower and Energy Generation:** Water is a renewable energy source for hydropower generation. Hydropower accounts for about 16% of global electricity generation (IEA). India has the potential to generate up to 148 gigawatts of hydropower, meeting about 40% of the country's electricity needs (WRI, NITI Aayog).
- **Transportation:** Waterways historically served as vital transportation routes. About 90% of world trade carried by sea (IMO). Inland waterways in India can transport about 50 million tons of cargo per year (NITI Aayog), with an economic value estimated at about $1 billion per year (WRI).
- **Global Water Cycle:** Water resources are part of the Earth's water cycle, crucial for predicting weather patterns. India receives about 4,000 billion cubic meters of rainfall per year, contributing about 4% to the world's total annual rainfall (NITI Aayog, WRI).

"**Note:** Here, FAO means Food and Agriculture Organisation, WRI means World Resources Institute, IEA means International Energy Agency, IMO means International Meterological Organisation, NOAA means National Oceanic and Atmospheric Administration, WHO means World Health Organisation, IPCC means Intergovernmental Panel on Climate Change and UNEP means United Nations Environment Programme."

Issues and Challenges Related to Water Resources

1. **Water Scarcity:** NITI Aayog Composite Water Index has pointed out that rapid population growth, urbanisation, and increased water demand for agriculture and industry contribute to water scarcity in many regions. This scarcity is exacerbated by uneven distribution and inefficient water use.
   - **Overexploitation of Groundwater:** Excessive extraction depletes groundwater levels, especially in agricultural regions.
   - **Pollution of Water Sources:** Water pollution threatens available water sources, affecting both quantity and quality, challenging meeting growing demand.
   - **Inadequate Infrastructure:** Emphasis on the need for improved infrastructure for water resource management, including storage, distribution, and treatment facilities.
   - **Rapidly Increasing Population:** India's projected population of 1.6 billion by 2050 intensifies water demand, with over 600 million people already facing high to extreme water stress (NITI Aayog). Global population projected to reach 9.7 billion by 2050, further straining water resources.
   - **Urbanisation Pressure:** Over 60% of the population expected to reside in cities by 2050, leading to heightened competition for limited urban water supplies.
   - **Low Overall Water Management Performance:** India's water management performance classified as 'low' in NITI Aayog Composite Water Index - 2019, highlighting the need for enhanced strategies to optimize water utilization.
   - **Economic Consequences:** Water scarcity could cost India up to 6% of its GDP by 2050, emphasizing the far-reaching economic impacts associated with the current trajectory.

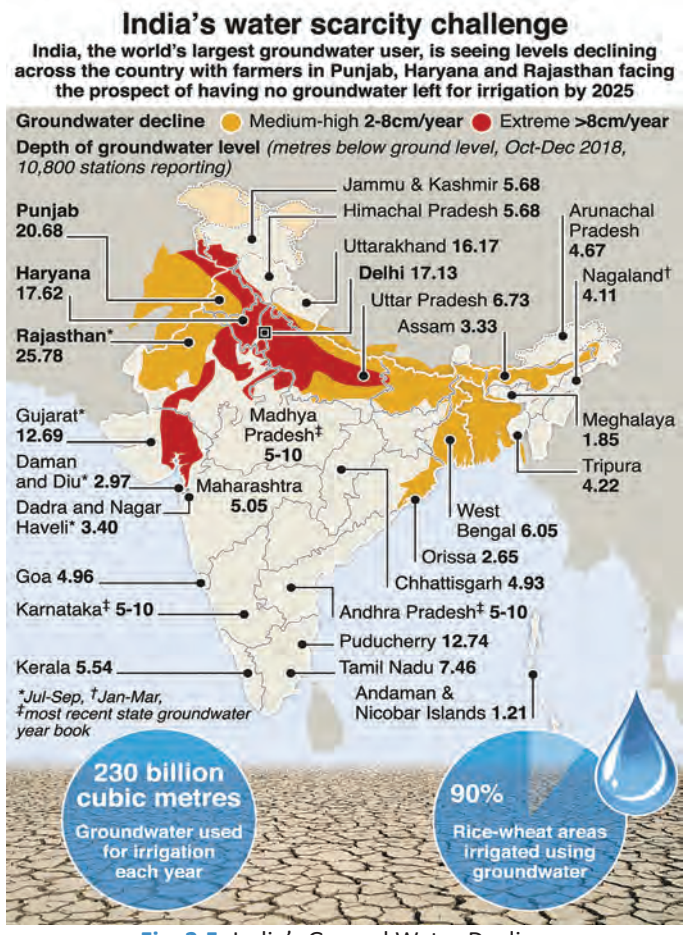


Fig. 2.5: India's Ground Water Decline

2. **Water Pollution:** The World Resources Institute (WRI) found that Contamination of water bodies by pollutants such as industrial chemicals, agricultural runoff, and untreated sewage poses a severe threat to water quality. Pollution negatively impacts ecosystems, aquatic life, and human health.

Causes of Water Pollution

- **Industrial Discharges:** Factories release pollutants, impacting water bodies. States with high industrial effluents: Gujarat, Tamil Nadu, Maharashtra (NITI Aayog 2023). Global economic cost of water pollution from industries: $8 trillion/year (WRI).
- **Agricultural Runoff:** Fertilizers and pesticides runoff pollute water. Agricultural runoff contributes to 50% of global water pollution (FAO).
- **Urban Runoff:** Urban areas contribute to water pollution. India ranks 120th in water quality globally (WRI). States with high urban runoff: Delhi, Kolkata, Bangalore (NITI Aayog 2023).
- **Improper Waste Disposal:** Inadequate waste disposal affects water. 70% of India's surface water bodies polluted (NITI Aayog 2023). States with high waste disposal: Bihar, Jharkhand, Uttar Pradesh.
- **Oil Spills:** Accidental or deliberate oil release harms aquatic ecosystems. Oil spills contribute to 5% of global water pollution (UNEP). Global cost of oil spills: $20 billion/year (WRI).
- **Mining Activities:** Mining introduces pollutants into water bodies. States with high mining activities: Rajasthan, Chhattisgarh, Odisha (NITI Aayog 2023). Mining contributes to 10% of global water pollution (UNEP). Global cost of water pollution from mining: $100 billion/year (WRI).

3. **Climate Change:** IPCC 6th Assessment Report highlights climate change impact on water availability. Altered precipitation patterns, rising temperatures, and extreme weather events affect water supply.

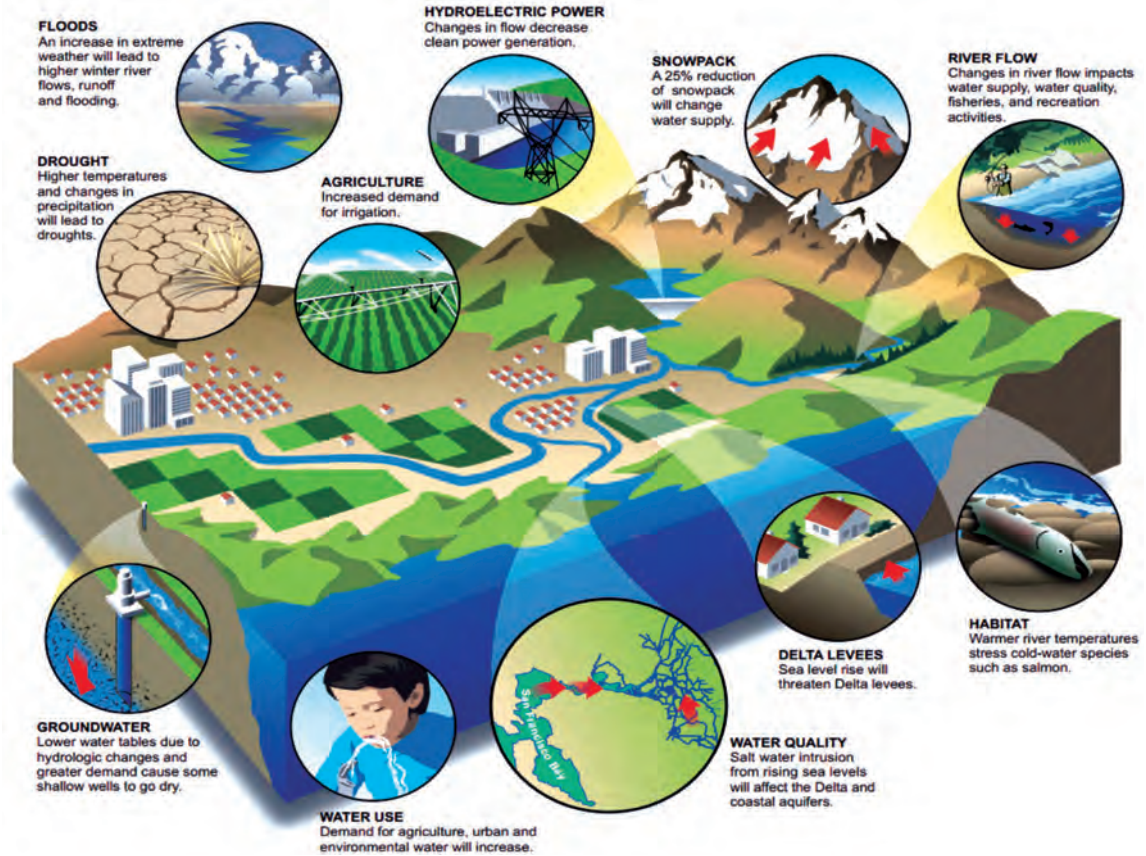

FLOODS
An increase in extreme weather will lead to higher winter river flows, runoff and flooding.
HYDROELECTRIC POWER
Changes in flow decrease clean power generation.
SNOWPACK
A 25% reduction of snowpack will change water supply.
RIVER FLOW
Changes in river flow impacts water supply, water quality, fisheries, and recreation activities.
DROUGHT
Higher temperatures and changes in precipitation will lead to droughts.
AGRICULTURE
Increased demand for irrigation.
HABITAT
Warmer river temperatures stress cold-water species such as salmon.
DELTA LEVEES
Sea level rise will threaten Delta levees.
GROUNDWATER
Lower water tables due to hydrologic changes and greater demand cause some shallow wells to go dry.
WATER QUALITY
Salt water intrusion from rising sea levels will affect the Delta and coastal aquifers.
WATER USE
Demand for agriculture, urban and environmental water will increase.

Fig. 2.6: Climate Change impact on Water Basins

Here are key aspects of the relationship between climate change and water resources:

- **Changes in Precipitation Patterns:** Climate change alters precipitation, causing uneven rainfall globally (WRI 2022). Increased frequency of extreme weather events like hurricanes and floods (IPCC). Glacial melting and changes in snowmelt impact river flow and ecosystems (IPCC).
- **Sea Level Rise and Saltwater Intrusion:** Rising sea levels lead to saltwater intrusion, compromising freshwater quality globally. Global sea levels risen by 8 inches since late 19th century, accelerating (UNEP).
- **Changes in Evaporation Rates:** Higher temperatures increase evaporation, reducing water availability. Evaporation rates in southwestern United States increased by over 10% since the 1970s (UC Berkeley 2021).
- **Shifts in Hydrological Cycles:** Climate change alters hydrological cycles, impacting river flows. Flow of the Colorado River decreased by over 20% since 1900s (NOAA 2020).
- **Impact on Water Quality:** Changes in temperature and precipitation influence water quality, increasing the risk of waterborne diseases.

4. **Rapid Groundwater Depletion:**
   - **Over-Extraction for Irrigation:** Agriculture is the largest consumer of groundwater globally (The World

Bank). 60% of India's groundwater is overexploited (NITI Aayog 2023). 30% of global irrigation water sourced from unsustainable groundwater use (The World Bank).

- **Urbanization and Industrial Growth:** Rapid urbanization and industrial growth deplete groundwater resources. India has the highest rate of groundwater depletion globally, with 10% overexploited each year (WRI 2023).
- **Population Growth:** Population growth intensifies groundwater depletion. 2.3 billion people live in areas with high groundwater depletion (UNEP).
- **Lack of Sustainable Water Management:** Inadequate water management contributes to over-exploitation. 17% of the world's total groundwater withdrawals are unsustainable (FAO).

5. Loss of Ecosystems due to Water Resource Development Projects"

Worldwide Impact:

- The **World Resources Institute's Aqueduct 4.0 Water Risk Atlas (2023)** underscores that dam construction, water diversion projects, and urban development significantly contribute to the loss and degradation of aquatic ecosystems globally.
- Approximately **80% of the world's freshwater ecosystems** are estimated to be threatened by these human activities, leading to substantial impacts on biodiversity and disrupting vital habitats.

Case Studies on Water Resource Development Projects

1. Ken-Betwa River Linking Project:

- **Overview:** The project aims to link the Ken and Betwa rivers in central India, transferring water to irrigate farmland in the Bundelkhand region.
- **Criticism:** Criticized for its potential devastation to the **Panna Tiger** Reserve, a critical habitat for tigers and endangered species.
- **Concerns:** Submergence of parts of the reserve, disruption of wildlife corridors, and the risk of increased poaching and habitat fragmentation.

2. Three Gorges Dam Project in China:

- **Overview:** The world's largest hydroelectric dam on the Yangtze River in China, offering substantial economic benefits.
- **Issues:** Significantly displaced millions, flooded vast areas, and disrupted fish migration patterns, causing environmental damage.
- **Challenges:** Balancing economic advantages with the environmental and social impacts of displacements and ecosystem disruptions.

3. Aral Sea in Central Asia:

- **Background:** Once the fourth-largest lake globally, the Aral Sea has shrunk over 90% due to water diversion projects for irrigation.
- **Consequences:** Extensive environmental damage, including dust storms, land salinization, and a severe loss of biodiversity.
- **Impact:** Highlights the repercussions of large-scale water diversion on ecosystems, emphasizing the need for sustainable water management.

India's Scenario:

- According to the **NITI Aayog's Composite Water Management Index (2019)**, around 70% of India's wetlands have been lost or degraded due to human activities, particularly those associated with water infrastructure development.
- Notably, the Sundarbans, a crucial delta in India, faces
- imminent threats, including rising sea levels that jeopardize freshwater resources.

IGNITE YOUR MIND

Dam Debate: Dams provide water and electricity, but also impact ecosystems. How can we balance the benefits and drawbacks of dams in water management? Also, analyse the idea of Interlinking of Rivers in this context.

6. Inadequate Sanitation, Inequitable Access:

- **Access Stats:** WHO notes 2.2 billion lack safe drinking water, 4.2 billion lack proper sanitation.
- **Health Impact:** Insufficient sanitation causes waterborne diseases, perpetuating poverty cycles.
- **Mortality Toll:** WRI estimates 425,000 annual deaths, majorly among under-five children.
- **Economic Cost:** Inadequate sanitation costs developing nations around $280 billion per year (World Bank).
- **Responsible Factors:**
  - **Infrastructure Gap:** Inadequate investment contaminates water sources. Open defecation contributes to pollution.
  - **Education Gap:** Lack of awareness leads to poor hygiene. Communities neglect facility construction.
  - **Poverty and Inequality:** Poverty results in inadequate sanitation. Economic disparities impact marginalized communities.
  - **Urban Challenges:** Overcrowded urban areas lack sanitation. Untreated sewage compromises water quality.
  - **Governance Issues:** Weak governance, lax regulation contribute to poor practices.

7. Water-Related Conflicts:

- FAO Estimate: By 2050, global water demand to surge by 55%, while supply remains constant, intensifying conflicts.
- **Types of Water-Related Conflicts:**
  - **Competition Among Users:**
    - Agriculture, industry, and municipalities vie for limited water resources, sparking conflicts locally and globally.
    - **Major Conflict Types:**
      - Water violence (Sub-Saharan Africa).
      - International Boundary Disputes (Indo-Bangla Teesta River Dispute).
      - Water Distribution Disputes (India-Pakistan Indus Water Treaty).

- **Predictions and Regions at Risk:**
  - **India's Water Deficit:** WRI predicts a 60% deficit by 2040, heightening competition and potential conflicts.
  - **High-Risk Regions:** Middle East, North Africa, Central Asia, South Asia.
  - **Current Conflict Landscape:** Over 250 active water-related conflicts worldwide, resulting in 500+ deaths annually (WRI Findings).
- **Causes of Water-Related Conflict:**
  - **Scarcity and Competition:** Population growth, climate change exacerbate competition for limited resources, escalating tensions.
  - **Unequal Access and Distribution:** Social and economic disparities drive conflicts over privileged access vs. shortages.
  - **Transboundary Water Issues:** Shared water bodies across borders lead to disputes over usage, extraction, and pollution.
  - **Governance Challenges:** Inadequate governance, weak institutions, lack of clear policies hinder conflict resolution.

8. Lack of Integrated Water Management:

- **NITI Aayog's Findings (2023):** India scores 40/100 in "Lack of Integrated Water Management," indicating substantial coordination and management gaps.
- **Causes:**
  - **Fragmented Governance:** Disputes, like the Mekong River Basin issue, show challenges in unified governance and coordination.
  - **Population Growth and Urbanization:** Instances in Beijing and Bengaluru illustrate how rapid urbanization strains water resources, leading to over-extraction.
  - **Climate Change Impact:** The shrinking Aral Sea and Maharashtra's droughts highlight water resource vulnerability to climate change.
  - **Infrastructure Gaps:** Africa's water losses due to inadequate infrastructure emphasize the need for modernization.
  - **Social and Economic Inequities:** Cape Town's water crisis and disparities in Rajasthan underline challenges in ensuring equitable water management.

9. Urbanization and Water Demand:

- **UN DESA Prediction (2050):** Global urban population to reach 6.6 billion, two-thirds of the world, intensifying water demand.
- **NITI Aayog's Projections (2023):**
  - India's urban water demand to surge by 50% by 2050.
  - Expected to reach 230 billion cubic meters per year by 2030.
  - Emphasizes over-exploitation of groundwater in urban areas.
- **WRI's Aqueduct 3.0 (2023) Estimates:**
  - Global urban water demand to hit 800 billion cubic meters per year by 2030.
  - Rising water scarcity challenges many cities worldwide, with a worsening trend due to continued urbanization.

10. "Regional Variations in Water Stress:

- Water stress occurs when there is either an insufficient quantity of water to meet demand during a specific period or when the quality of available water deteriorates, limiting its usability.

Causes

- **Geographical Factors:** Areas like Vidarbha and Marathwada face water stress due to their position in the rain shadow of the Western Ghats.
- **Agricultural Practices:** Regions cultivating water-intensive crops, like sugarcane in UP, often experience shortages compared to those with more water-efficient crops.
- **Population Density:** Urban areas in the Indus plains, with high population density, suffer from increased water stress.
- **Water Management Practices:** Varied techniques, from advanced recycling to traditional methods like bawris, contribute to differences in water stress. For instance, arid Rajasthan plains face fewer challenges due to superior water management.

How Does it Vary?

- **Himalayan States:** The melting glaciers, urbanization, pollution, and the decline of traditional water harvesting methods turn once water-abundant regions into water-stressed areas.
- **North Indian Plains:** Population pressure, untreated sewage, and excessive water usage for agriculture and industries contaminate rivers, impacting drinking water accessibility.
- **South India:** Erratic rainfall, pollution from developmental activities, inadequate agricultural practices, and excessive groundwater reliance contribute to severe drinking water shortages, exemplified by Chennai's recent crisis.
- **Northeast:** Abundant rainfall doesn't prevent water crisis due to factors like mining, pollution, and ineffective water conservation strategies.
- **Western India:** Arid climates in Rajasthan and Gujarat, coupled with incorrect cropping patterns in Maharashtra, lead to water scarcity.
- **Coastal Plains:** Rising sea levels and overexploitation of groundwater result in saline water intrusion, causing water stress.

Steps Taken to Mitigate the Issues

Global Measures

- **United Nations Initiatives:**
  - **Sustainable Development Goal 6 (SDG 6):** Aims for universal access to clean water and sanitation.
  - **UN Water:** Coordinates global efforts on freshwater-related issues.
- **Public-Private Partnerships:**
  - **2030 Water Resources Group (2030 WRG):** Collaborates for improved water management in stressed countries.

- **"Blue Finance Action Group":** Mobilizes private sector investment for water projects in developing nations.

❑ **NGOs Addressing Water Crisis:**
- **Water.org:** Provides access to safe water and sanitation in developing countries.
- **"WaterCredit Initiative":** Offers microloans for water and sanitation solutions.
- **Water for Food Global Institute:** Focuses on policies for water and food security.

❑ **Tools and Resources for Action:**
- **"Food-Water-Nexus Toolkit" and "Global Food-Water-Energy Nexus Platform":** Provide practical steps and knowledge sharing for integrated resource management.
- **World Water Forum:** Triennial event for stakeholders to address global water challenges.
- **"Water Action Hub":** Online platform sharing solutions and best practices for water challenges.

❑ **International Collaborative Networks:**
- **Global Water Partnership (GWP):** Supports sustainable water resource management worldwide.
- **Water, Peace, and Security Partnership:** Works to prevent conflicts over water and promote peace.
- **Capacity Building and Technical Assistance:** "Technical Support Facility": Offers targeted assistance to countries facing water challenges.
- **Guidelines for Cooperation:** "Transboundary Water Cooperation Guidelines": Provides advice for managing shared water resources.
- **"Be the Change" Campaign:** Promotes individual and collective action for water sustainability.

Indian National Measures

❑ **The National Water Policy (2012):**
- The National Water Policy is a comprehensive framework for water management in India. The policy aims to ensure the sustainable development and management of water resources in India.

❑ **The Jal Jeevan Mission:**
- The Jal Jeevan Mission is a flagship program of the Indian government that aims to provide safe and sustainable drinking water to all rural households in India by 2024.

❑ **The Atal Bhujal Yojana:**
- The Atal Bhujal Yojana is a program of the Indian government that aims to conserve and replenish groundwater resources in India.

❑ **The National River Conservation Programme:**
- The National River Conservation Programme is a program of the Indian government that aims to conserve and protect India's rivers.

❑ **The Dam Rehabilitation and Improvement Project:**
- The Dam Rehabilitation and Improvement Project is a project of the World Bank that aims to improve the safety and performance of dams in India.

❑ **Namami Gange (National Mission for Clean Ganga):**
- Launched in 2014, this initiative aims to clean and rejuvenate the Ganges River and its tributaries. It focuses on reducing pollution, conserving biodiversity, and promoting sustainable use of water resources.

❑ **Pradhan Mantri Krishi Sinchayee Yojana (PMKSY):**
- This scheme, launched in 2015, aims to enhance the physical and financial access of farmers to irrigation. It includes the development of water sources, efficient water management, and distribution of water resources for agricultural purposes.

❑ **National Water Mission (NWM):**
- Part of the National Action Plan on Climate Change, the NWM was launched in 2011. It aims to conserve water, minimise wastage, and ensure its more equitable distribution through integrated water resources management.

❑ **National Hydrology Project (NHP):**
- This project, initiated in 2016, aims to improve the extent, quality, and accessibility of water resources information in the country. It focuses on strengthening the capacity of institutions involved in water resources management.

India's National Water Policy 2012 (NWP 2012)

The National Water Policy 2012 is the current policy framework governing water resource management in India.

Basic Principles:

❑ **Integrated Approach:** Water resources need to be managed as a whole, considering **local, regional, state, and national** contexts. Planning and development should be **environmentally sound** and cater to **human, social, and economic needs**.

❑ **Community Resource:** Water is a **common pool resource** held by the state under the **public trust doctrine**. Management should aim for **food security, livelihoods**, and **equitable and sustainable development** for all.

❑ **Ecological Needs:** Minimum ecological needs of water bodies should be considered a priority.

Key Policy Features:

❑ **Demand Management:** Promoting **water conservation, rainwater harvesting,** and **efficient irrigation practices**.

❑ **Water Pricing:** Equitable water pricing with a focus on **affordability** for basic needs and **recovery of costs** for commercial use.

❑ **Conflict Resolution:** Mechanisms for resolving **water disputes** between states or user groups.

❑ **Regulatory Framework:** Strengthening institutions for **water management** and **regulation**.

❑ **Public Participation:** Encouraging **community involvement** in water resource planning and management.

❑ **Climate Change Adaptation:** Recognizing the challenges of **climate change** and adopting strategies for **sustainable water management** in a changing environment.

Draft National Water Policy (Latest): The **NWP 2012** is under revision to address emerging water challenges. A **draft policy** was prepared by a committee in **2021**. It includes:

❑ **Focuses on participatory water management:** Encourages **community involvement** in decision-making and planning.

- **Emphasizes water quality:** Addresses **water pollution** issues more comprehensively.
- **Strengthens regulatory framework:** Aims for **stricter regulations** and **enforcement** to ensure sustainable water use.
- **Adapts to climate change:** Proposes strategies to manage water resources under **changing climatic conditions**.
- **Current Status:** The **draft National Water Policy** is under review by the government. No official date for its implementation has been announced.

IGNITE YOUR MIND

Policy Puzzles: The National Water Policy aims to manage water resources sustainably. How effective has it been? What improvements could be made?

India's National Water Policy reflects a commitment to holistic water management, incorporating considerations for quality, sustainability, and societal awareness. Hence, the current policy requires updation to address new challenges, particularly the detrimental impacts of climate change.

Jal Kranti Abhiyan

Water, a recyclable resource, faces increasing challenges due to limited availability and a widening the gap between supply and demand. Global climate change intensifies water stress conditions worldwide, and India, with high population growth and rapid economic development, finds itself in a unique situation with soaring water demand.

Initiative Launch: The **Jal Kranti Abhiyan**, initiated by the Government of India in 2015–16, seeks to address water security by enhancing per capita water availability across the country. Leveraging traditional knowledge of water conservation and management, the campaign aims to involve local bodies, NGOs, and citizens at large to create awareness and achieve its objectives.

Key Objectives and Proposed Activities:

- **Jal Gram Creation:** Selection of one water-stressed village in each of the 672 districts to establish a 'Jal Gram.'
- **Model Command Areas:** Identification of model command areas, approximately 1000 hectares each, in diverse regions like UP, Haryana (North), Karnataka, Telangana, Tamil Nadu (South), Rajasthan, Gujarat (West), Odisha (East), Meghalaya (North-East).
- **Pollution Abatement:**
  - Implementation of measures for water conservation and artificial recharge.
  - Focus on reducing groundwater pollution.
  - Construction of arsenic-free wells in selected areas of the country.
- **Mass Awareness:** Creation of awareness through various channels, including social media, radio, TV, print media, posters, and essay writing competitions in schools.

Holistic Approach:

Jal Kranti Abhiyan is not merely a water conservation initiative; it is designed to provide **livelihood and food security** by ensuring water security. By integrating traditional wisdom and modern solutions, the campaign aspires to address the pressing water-related challenges facing India.

These measures are important for ensuring that we have enough clean water to meet the needs of a growing population, and for protecting our environment from the impacts of climate change.

Watershed Management

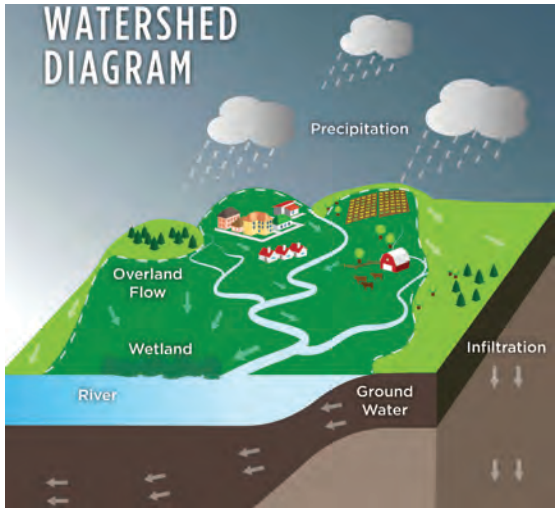


Fig. 2.7: Watershed

About Watershed:

- A watershed, also called a **drainage basin or catchment area**, is an area of land that drains water into a specific water body.
- Independent drainage unit for **surface water runoff**.
- Separated from other watersheds by a natural boundary known as the **water divide or ridge line**.
- A **national system** developed by the **Department of Agriculture's All India Soil and Land Use Survey Organization**.
- Watersheds are categorized into four types: **Basins, Catchments, Sub-catchments, and Watersheds.**
- India boasts **3200 watersheds, 112 catchments, 35 rivers, and 500 sub-catchments**.

Types of Watersheds:

- Macro Watershed (> 50,000 Ha)
- Sub-watershed (10,000 to 50,000 Ha)
- Milli-watershed (1000 to 10,000 Ha)
- Micro Watershed (100 to 1000 Ha)
- Mini Watershed (1-100 Ha)

About Watershed Management:

- Watershed management, a practice essential for environmental sustainability, integrates seamlessly with economic geography. It is a flexible and comprehensive planning process, aims to harmonize ecological, economic, and social conditions within a designated area. This approach involves various stakeholders such as communities, landowners, environmental experts, and water usage surveyors.

Watershed Management - Planning and Significance:

- **Thorough Planning:** Detailed planning involves acquiring maps through remote sensing to characterize natural resources.
- **Satellite Imaging:** Utilizing satellite imaging to estimate crop areas, output, and identify key locations like check dams.
- **Resource Distribution:** Satellite images help determine resource distribution patterns, leading to detailed planning.

Significance of Watershed Management:

- **Pollution Control:** Reduces contamination of natural resources within the watershed.
- **Regulating Activities:** Identifies and regulates ecologically hazardous activities, minimizing negative effects.
- **Enhanced Partnerships:** Strengthens partnerships among stakeholders for effective land and water resource management.
- **Limited Resource Optimization:** Helps organise implementation during resource limitations.
- **Inclusive Growth:** Essential for inclusive and sustainable growth, supporting varied revenue sources in rainfed areas.
- **Improved Water Quality:** Enables the improvement of water quality for household, agricultural, and industrial use.
- **Agricultural Productivity:** Increases agricultural productivity through diverse cropping systems.

Advantages of Micro watershed Management:

- **Localised Approach:** Micro-watershed development projects focus on small, localised areas, tailoring solutions to unique watershed characteristics. This targeted approach allows for customised water conservation strategies based on factors like topography, soil type, and land use patterns.
- **Soil and Water Conservation:** These projects implement various measures such as contour bunding, check dams, terracing, and afforestation. Aimed at enhancing rainwater infiltration, reducing soil erosion, and increasing groundwater recharge, these measures improve water availability for vegetation and groundwater replenishment, crucial in drought-prone regions.
- **Community Participation:** Micro-watershed development projects emphasise community involvement in planning, implementation, and management. By empowering local communities to take ownership of water conservation initiatives, these projects foster a sense of responsibility and ensure long-term sustainability.
- **Integrated Approach:** These projects adopt an integrated approach considering various aspects of watershed management including agriculture, forestry, livestock management, and water supply. By addressing multiple aspects simultaneously, they promote synergies among different sectors and maximise the benefits of water conservation efforts.
- **Livelihood Improvement:** Micro-watershed development projects aim to enhance livelihoods in rural communities by improving water availability for irrigation, livestock, and domestic use. This contributes to increased agricultural productivity, improved food security, and diversified livelihood options, thereby reducing vulnerability to droughts.
- **Cost-effectiveness:** Compared to large-scale water management projects, micro-watershed development projects are often more cost-effective. Requiring relatively lower investments in infrastructure and machinery while delivering tangible benefits at the local level, they offer a cost-effective solution for addressing water scarcity.

  Overall, micro-watershed development projects offer a holistic and participatory approach to water conservation in drought-prone and semi-arid regions of India.

Integrated Watershed Management Programme (IWMP):

- **Launch:** Launched in 2009–10 by the **Ministry of Rural Development**.

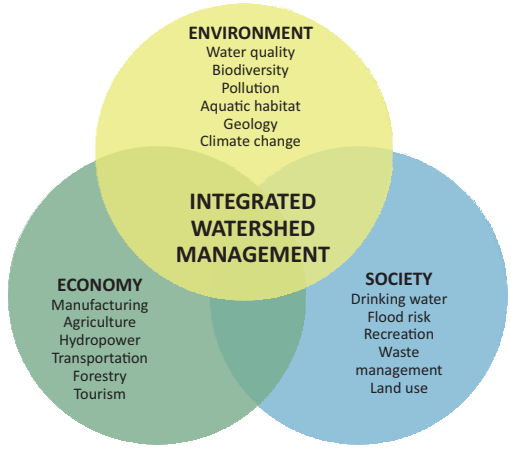


Fig. 2.8: Watershed Management

- **Merger:** Merged three area development programs: **Desert Development Programme (DDP), Drought Prone Areas Programme (DPAP), Integrated Wastelands Development Programme (IWDP).**
- **Scope:** Aims to encompass **55 million hectares** of rainfed land by **2027**.
- **Global Standing:** Second largest watershed program globally after China's.
- **Objective:** Aims to **restore ecological balance** by **harnessing, conserving, and developing degraded natural resources**.
- **Funding:** Implemented in every state with central and state governments' funding in a 90:10 ratio.
- **Local Participation: Gram Panchayats** actively involved for **transparency and local participation.**

Watershed Management - Related Initiatives:

- **Haryali Watershed Development Project:**
  - **Objective:** Central Government-funded project focusing on water conservation in rural areas.
  - **Focus Areas:** Emphasizes on drinking, irrigation, fisheries, and afforestation.

- **Neeru-Meeru (Water and You) Program:**
  - **Initiative:** Public-assisted program in Andhra Pradesh and Arvary Pani Sansad in Alwar, Rajasthan.
  - **Activities:** Involves construction of water-harvesting structures through public participation.
- **Tamil Nadu's Mandate for Water Harvesting Structures:**
  - **Requirement:** Mandates water harvesting structures in houses.
  - **Regulation:** Prohibits building construction without these structures.

Issues and Challenges in Watershed Management Programmes:

- **Project-Related Issues:**
  - **Challenges:** Addressing outdated approaches, poor project design, insufficient resources, and inadequate knowledge.
- **Legal Support Deficiency:**
  - **Challenge:** The absence of robust **legal support** for watershed management policies hampers effective implementation.
- **Institutional Weakness:**
  - **Challenge:** Weak **institutional frameworks** and inadequate incorporation of **self-help groups** hinder sustainability.
- **Initiatives Excluding Reserved Forestlands:**
  - **Challenge:** Lack of coordination between **rural development** and **forestry departments** impedes progress.

IGNITE YOUR MIND

Raincatcher: Imagine designing a system to collect rainwater in your community. What factors would you consider, and how would it benefit people and the environment?

Way Forward in Watershed Management:

- **Build Local Partnerships:**
  - **Objective:** Foster partnerships for greater awareness and support.
  - **Action:** Enhance community involvement in decision-making and restoration efforts.
- **Determine Priorities for Action:**
  - **Strategy:** Identify and prioritize opportunities to reduce pollution and address environmental issues.
- **Conduct Educational Programs:**
  - **Approach:** Public education and participation significantly influence **watershed management success**.
- **Effective Implementation and Follow-Up:**
  - **Approach:** Implement **dynamic and adaptive** watershed planning.
  - **Monitoring:** Regularly **monitor long-term responses** for **vital adjustments**.

Future Trends:

- **Technology Integration:** Increasing reliance on technology for real-time water quality monitoring and mapping.
- **Climate Change Adaptation:** Adapting watershed management plans to address climate change challenges.
- **Collaboration Enhancement:** Strengthened collaboration among communities, businesses, and governments for effective watershed management.

Watershed management emerges as a **vital tool** in the intersection of economic geography and environmental sustainability.

Rainwater Harvesting

Rainwater harvesting is the collection, storage, and use of rainwater for later beneficial purposes. It typically involves capturing rainwater from surfaces like rooftops, paved areas, and natural landscapes and storing it in tanks, cisterns, or underground aquifers.

- **Modern Rainwater Harvesting:**
  - **Catchment:** Collects and stores captured rainwater.
  - **Conveyance System:** Transports harvested water.
  - **Flush:** Eliminates initial rain.
  - **Filter:** Removes pollutants.
  - **Tanks and Recharge Structures:** Store filtered water for various uses.

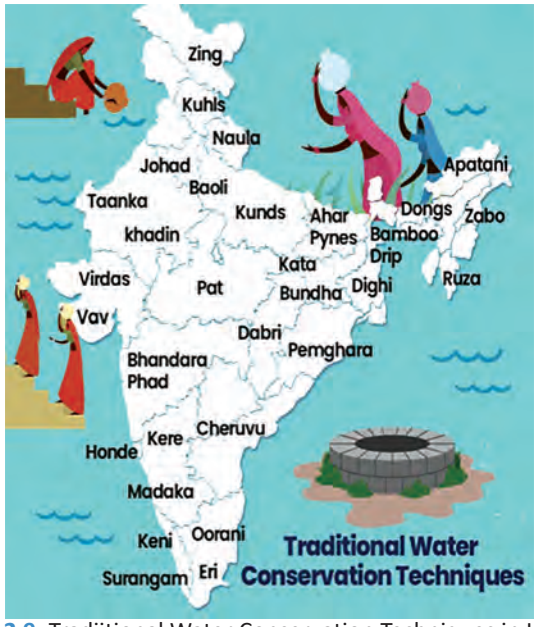


Fig. 2.9: Tradiitional Water Conservation Techniques in India

- **Traditional Techniques:**
  - **Northern India:** Kuls, Araghatta, Johads, Khadins, Jhalaras, Talabs, Bawaris, Taanka, Nadi, Kuhls
    - **Kuls:** Mountain channelsin Jammuand Himachal Pradesh.
    - **Tanka System:** Cylindrical ground pit in Rajasthan.
    - **Khadin:** Long earthen embankment in Rajasthan.
  - **Southern India:** Kovil Kulam, Surangas, Eri, Panam Keni.
  - **Eastern India:** Ahar Pynes, Johads, Jackwells.
  - **Western India:** Virdas, Kunds, Bhandara Phad, Ramtek model.
    - **Virdas:** Shallow wells in Runn of Kutch, Gujarat.
    - **Stepwell:** Found in Rajasthan and Gujarat.

- **North-East India:** Bamboo drip system, Zabo.
  - **Bamboo Drip Irrigation:** Used in the northeast, suitable for hilly terrains.
- Others include Madaka, Tanks in Karnataka, Zing-Tanks, Baoris/Bers, Apatani, Pyne-ahar, etc.
  - **Baoris/Bers** are communal wells found in Rajasthan.
  - **Apatani** involves terraced plots interconnected by inlet and outlet channels in Arunachal Pradesh.
  - **Pyne-ahar** is a traditional system in South Bihar crucial for paddy cultivation.

Significance of Rainwater Harvesting:

- **Addressing Water Crisis:**
  - **Food Security:** Over 60% of India's net sown area is rainfed.
  - **Runoff and Evaporation Control:** Ensures optimal rainfall utilization.
- **Urbanization and Industrial Development:**
  - **Alleviating Water Crunch:** Provides decentralized water sources.
  - **Remote Region Relief:** Reduces hardships, especially in remote areas.
- **Future Directions:**
  - **Reduce Dependency on Groundwater:**
    - **Enhancing Water Security:** Rejuvenating natural and constructed water bodies.
    - **Treated Wastewater Reuse:** Through local sewage treatment plants.
  - **Technology and Science Solutions:**
    - **Nanotechnology:** For water purification.
    - **Intelligent Irrigation Systems:** Smart water management.
    - **Mobile Water Purification Units:** Portable solutions.
- **Regulations and Support:**
  - **Kerala:** Well recharging program 'Mazhapolima' implemented statewide.
  - **Tamil Nadu:** Mandatory rainwater harvesting facilities for buildings.
  - **Karnataka:** Tourism department funding medieval structure restoration.
  - **Importance of Involvement:** Popularizing rainwater harvesting.

Urban Rainwater Harvesting:

- **Challenges:**
  - **Shrinking Open Spaces:** Limited unpaved areas.
  - **Contributing to Issues:** Both flooding and water scarcity.
- **Urban RWH Methods:**
  - **Rooftop Rainwater Harvesting:** Groundwater recharge.
  - **Surface Runoff Harvesting:** Reviving water bodies without further construction.
- **Way Forward:**
  - **Reduce Dependency:** Emphasis on water security, rejuvenation, and wastewater reuse.
  - **Collaboration:** Between Central and State governments for effective implementation.
  - **Stakeholder Involvement:** Key for successful watershed development.
  - **Enhanced Legal Frameworks:** Standard procedures and laws needed.
  - **Promotion Strategies:** Rewards, awareness, and penalties.

Steps taken to promote Rain Water Harvesting

India has taken major strides in promoting rainwater harvesting, from government initiatives like Jal Shakti Abhiyan to community projects and private sector involvement.

- **Jal Shakti Abhiyan:** Launched in 2019, this nationwide campaign aimed to improve water conservation and rainwater harvesting across India. Its expanded version, "Jal Shakti Abhiyan: Catch the Rain" (JSA:CTR) covers all districts and promotes harvesting rain where it falls.
- **Atal Bhujal Yojana:** This scheme offers financial assistance to states for groundwater recharge and rainwater harvesting projects in water-stressed areas.
- **Model Building Bye Laws:** The Ministry of Housing and Urban Affairs has mandated rainwater harvesting systems in new buildings in 51 cities and is encouraging other cities to follow suit.
- **Subsidies and incentives:** Many states offer subsidies and other incentives for installing rainwater harvesting systems, especially for individual households and farmers.
- **Awareness campaigns:** Government agencies and NGOs regularly conduct awareness campaigns to educate people about the importance and benefits of rainwater harvesting.

Conclusion:

- **Critical Intersection:** Rainwater harvesting for economic geography and environmental sustainability.
- **Solution to Crisis:** Offers answers to India's escalating water scarcity.

Steps Taken to Counter Water Pollution

In India, combating water pollution involves a multifaceted approach encompassing legislative measures, regulatory bodies, and targeted programs. From national policies to grassroots initiatives, a range of strategies is employed to address pollution in various sectors, ensuring the sustainability of water resources.

- **Central Pollution Control Board (CPCB):** As India's apex body, CPCB formulates and enforces water pollution control standards. It conducts research, monitors water quality, and ensures industries comply with effluent norms, contributing to comprehensive national pollution control.
- **National Ganga River Basin Authority (NGRBA):** Established to oversee Ganges River conservation, NGRBA implements strategies, projects, and policies to reduce pollution, promote sustainable practices,

and engage communities in the restoration of the sacred river.

- **Water (Prevention and Control of Pollution) Act, 1974:** This legislation provides the legal foundation for water pollution control in India. It empowers authorities to regulate and prevent water pollution, facilitating the establishment of the CPCB and State Pollution Control Boards.
- **National Water Policy:** Guiding water resource development, this policy emphasizes pollution control, efficient water use, and sustainable management. It outlines principles for water governance, encouraging integrated approaches to safeguard water quality and availability.
- **National River Conservation Plan (NRCP):** Launched to address pollution in major rivers, NRCP focuses on sewage treatment, industrial pollution control, and solid waste management. It aims to rejuvenate rivers, with targeted interventions and community involvement in pollution abatement.
- **Atal Mission for Rejuvenation and Urban Transformation (AMRUT):** AMRUT aims to improve urban infrastructure, including water supply and sewage management. By enhancing basic services, it addresses pollution challenges in urban areas, ensuring sustainable development and water resource management.
- **Namami Gange Programme:** An integrated approach to Ganges rejuvenation, Namami Gange includes pollution abatement measures, riverfront development, and public awareness. It seeks to cleanse and conserve the Ganges, fostering sustainable practices and community involvement.
- **Effluent Standards:** The CPCB sets and enforces effluent standards for industries, regulating the discharge of pollutants into water bodies. Stringent standards ensure industries adopt cleaner technologies and practices, minimizing water pollution from industrial sources.
- **Green Chemistry Initiatives:** Encouraging industries to adopt environmentally friendly processes, green chemistry initiatives focus on reducing the use of hazardous substances and promoting sustainable practices. This contributes to minimizing water pollution associated with industrial activities.
- **National Mission for Clean Ganga (NMCG):** Part of the Namami Gange Programme, NMCG includes initiatives to control agricultural runoff, promoting sustainable agricultural practices to reduce water pollution in the Ganges River basin. It addresses non-point source pollution, a key concern for river health.
- **Integrated Watershed Management Programme (IWMP):** Aimed at conserving soil and water, IWMP focuses on sustainable land management practices to reduce agricultural runoff and associated water pollution. By promoting watershed development, it addresses soil erosion and water quality concerns.

India's concerted efforts to counter water pollution demonstrate a commitment to sustainable water management. Through stringent regulations, proactive policies, and community engagement, the nation endeavors to safeguard its water bodies, promoting a cleaner and healthier environment for present and future generations.

IGNITE YOUR MIND

Watery Wisdom: Millions of liters of wastewater go untreated in India. How can we recycle and reuse wastewater more effectively? What can we learn from water management practices in other countries, like Israel's innovative solutions for water scarcity? How can we adapt these practices to our own contexts?

The Way Forward

Combat water pollution through advanced technologies like nanotechnology and AI monitoring. Enforce strict regulations with penalties, and promote nature-driven solutions such as wetlands. Engage communities, incentivize eco-friendly industry practices, and foster global cooperation. Invest in research on emerging pollutants and embrace circular practices for effective pollution control.

This streamlined approach ensures effective water pollution control and sustainable water resource management.

Food and Agriculture Organization of the United Nations (FAO)

- **Irrigation Water Use:** FAO estimates that irrigation water use accounts for about **70% of total water withdrawals worldwide**. Agriculture is the largest user of water, accounting for about 69% of global water withdrawals.
- **Groundwater Resources:** FAO estimates that **groundwater provides about 50% of all drinking water and 43% of all agricultural irrigation worldwide**. Groundwater is an important source of water for many communities, especially in arid and semi-arid regions.
- **Global Water Information System (AQUASTAT):** FAO's AQUASTAT is a comprehensive online database of water resources information for over 245 countries and territories. It includes data on water availability, water use, water quality, and water governance

United Nations Environment Programme (UNEP)

- **The 2021 UN-Water Annual Report:** UNEP's 2021 UN-Water Annual Report found that the world is facing a water crisis, with an estimated 2.3 billion people lacking access to safe drinking water and 4.2 billion people lacking access to sanitation.
- **The Global Environment Outlook 6 (GEO-6):** UNEP's GEO-6 report found that water pollution is a major threat to human health and the environment. **It is estimated that 80% of wastewater is discharged untreated into the environment, polluting rivers, lakes, and groundwater**.

World Resources Institute (WRI)

- **Aqueduct Water Risk Atlas:** WRI's Aqueduct Water Risk Atlas is an online tool that maps water stress, water pollution, and flood risk around the world. The Atlas can be used to identify areas that are at risk of water scarcity, pollution, and flooding.

World Bank

- **Water and Agriculture Global Facility (WAGF):** The WBG's WAGF is a multi-donor trust fund that provides grants to support investments in sustainable water and agriculture development. The WAGF has supported over 200 projects in over 70 countries.
- **The Water and Sanitation Program (WSP):** The WSP is a multi-donor partnership that provides technical and financial assistance to countries to improve water and sanitation services. The WSP has supported over 1,000 projects in over 80 countries.
- **The Global Water Security & Sustainability Program (GWSP):** The GWSP is a multi-partner initiative that aims to help countries achieve water security by 2030. The GWSP is working to improve water governance, finance, and data.

At National Level-

1. Central Water Commission (CWC)

- **Water Storage Status:** As of October 2023, the average water storage in 91 important reservoirs across India was **29.2% of their capacity, lower than the corresponding period of previous years**. This is due to below-average rainfall during the monsoon season.
- **Surface Water Availability:** The total utilisable surface water resources in India are estimated to be **1,122 cubic kilometres (BCM), with an annual average surface water availability of 1,170 BCM**. However, the actual annual surface water availability varies significantly depending on the monsoon season.
- **Groundwater Availability:** India's groundwater resources are estimated to be **453 billion cubic metres (BCM), with an annual replenishable groundwater potential of 400 BCM**. However, groundwater extraction is exceeding recharge rates in many regions, leading to groundwater depletion and water scarcity issues.

2. Ministry of Jal Shakti, Government of India

- **Water Quality:** The Ministry has initiated various programs to improve water quality in India, including the National Water Policy 2012 and the National Mission for Clean Ganga. Despite these efforts, water quality remains a major concern, with high levels of pollution in many rivers and lakes.
- **Wastewater Treatment:** India generates an estimated 62 billion litres per day (BLD) of wastewater, but only 37% of it is treated. The Ministry is promoting wastewater treatment projects to improve sanitation and reduce pollution.
- **Watershed Management:** The Ministry is promoting watershed management practices to improve water conservation and recharge groundwater resources. Watershed management involves activities such as afforestation, soil conservation, and rainwater harvesting.

3. National Water Development Agency (NWDA)

- **Inter-basin Water Transfer Projects:** The NWDA is implementing several inter-basin water transfer projects to augment water availability in water-scarce regions. These projects involve the construction of dams, canals, and tunnels to transfer water from surplus basins to deficit basins.
- **Hydropower Generation:** The NWDA is also responsible for developing hydropower projects in India. Hydropower is an important source of renewable energy in India, and the NWDA is working to harness the potential of India's rivers for hydropower generation.

4. National River Conservation Directorate (NRCD)

- **River Conservation Programs:** The NRCD is implementing various river conservation programs to restore the health of India's rivers. These programs involve activities such as cleaning up pollution, restoring riparian vegetation, and promoting sustainable river basin management practices.

IGNITE YOUR MIND

Virtual Voyage: How much "hidden water" is embedded in everyday products like clothes or electronics? How can we reduce our virtual water footprint and consume more consciously?

- **Ganga Rejuvenation Program:** The NRCD is playing a key role in the Ganga Rejuvenation Program, which aims to restore the health of the Ganga River and its tributaries. The program includes a range of activities to reduce pollution, improve water quality, and manage water resources sustainably.

Best Practices in Water Management: India & the World

India

- **Hiware Bazar, Maharashtra:** Transformed from environmental degradation to prosperity within a decade, Hiware Bazar utilized government funds for holistic restoration under a strong village body, setting an example for the entire Ahmednagar district.
- **Jagat Singh Jangli, Uttarakhand:** Known as "Jungli," he turned 1.5 hectares of barren land into a thriving agroforest, contributing to biodiversity, sustainable practices, and community development, earning accolades like the 'Indira Gandhi Vrikshamitra.'
- **Pani Panchayat:** Originating in the drought-prone Naigaon village, Salunkhe's Pani Panchayat concept focused on collective water conservation as a common property resource, transforming impoverished lands into prosperous villages.

Global

- **Ogata Village Rainwater Harvesting System, Japan:** Exemplifying sustainable water management, this

community-based system in Japan collects and stores rainwater from rooftops, reducing reliance on external sources and enhancing drought resilience.

- **Netafim Drip and Micro Irrigation Systems:** Netafim, an Israeli company, addresses global water scarcity with its innovative drip and micro irrigation systems, operating in over 170 countries. These systems enhance water use efficiency by up to 90%, contributing significantly to global water management challenges.
- **The "Singapore's Four National Taps" Water Management Strategy:** Singapore is a city-state with limited water resources. To meet its water needs, Singapore has developed a comprehensive water management strategy called the "Four National Taps." The Four National Taps are:
  - **Local catchment water:** This is water that is collected from rainwater and runoff.
  - **Imported water:** This is water that is imported from neighbouring countries.
  - **Reclaimed water:** This is wastewater that is treated and reused.
  - **Desalinated water:** This is seawater that is converted into freshwater.

  The Four National Taps have helped Singapore to become one of the most water-efficient countries in the world.

Recommendations by OECD for Water Resource Management

- **Enhance water conservation efforts**
  - Implement water-efficient technologies and practices in agriculture, industry, and households.
  - Promote rainwater harvesting and greywater reuse to reduce reliance on freshwater sources.
  - Raise public awareness about water conservation and encourage behavioural changes.
  - **Water conservation:** Water conservation efforts include reducing water consumption through water-efficient appliances and practices, such as fixing leaky faucets and watering lawns less often.
- **Improve water infrastructure**
  - Invest in upgrading and expanding water supply and wastewater treatment systems.
  - Address water leakage and distribution losses to improve water use efficiency.
  - Develop innovative infrastructure solutions, such as smart water grids, to optimise water management.
- **Strengthen water governance and institutions**
  - Establish clear water policies and regulations that promote sustainable water management.
  - Enhance coordination and collaboration among different agencies responsible for water management.
  - Empower local communities to participate in water management decision-making.
- **Protect water quality**
  - Implement stricter regulations and enforcement mechanisms to prevent water pollution.
  - Reduce agricultural runoff and industrial wastewater discharges.
  - Implement watershed management practices to protect water bodies from contamination.
  - **Water pollution control:** Water pollution control efforts include treating wastewater before it is discharged into rivers and other water bodies.
- **Promote water-sensitive urban design**
  - Incorporate green infrastructure and sustainable urban planning principles to manage stormwater and improve water quality.
  - Create urban spaces that conserve and reuse water, such as green roofs and bioswales.
  - Foster partnerships between urban planners, water managers, and landscape architects to integrate water into urban design.
- **Address water scarcity and climate change impacts**
  - Develop drought preparedness and response plans to mitigate the impacts of climate change on water availability.
  - Invest in water storage and rainwater harvesting systems to capture and store water during periods of excess rainfall.
  - Promote climate-smart agriculture practices that optimise water use and reduce vulnerability to climate change.
  - **Rainwater harvesting:** Rainwater harvesting is the collection and storage of rainwater for later use. This practice is becoming increasingly common in India, as it is a sustainable way to supplement water supplies during dry periods.
- **Foster international cooperation on water resources**
  - Support transboundary water management agreements and initiatives to share water resources equitably and sustainably.
  - Promote knowledge exchange and capacity building among countries to address water challenges.
  - Encourage collaboration on research and innovation in water technologies and management approaches

LAND RESOURCES

Land resources encompass diverse geographical features, notably classified into **plains, mountains, and plateaus**, each playing a unique role in shaping ecosystems and human activities.

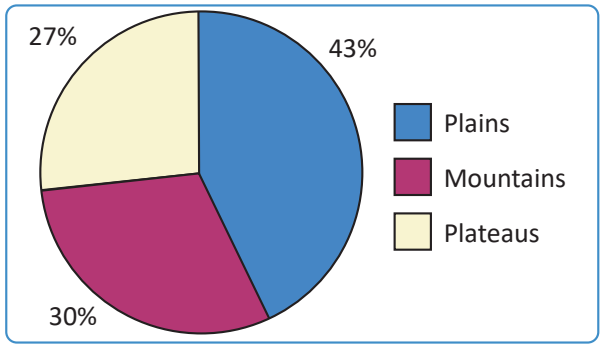


Fig. 2.10: Land under important Relief Features"

- To meet the challenging demand of food, fibre and fuel for the human population, fodder for animals and industrial raw material for agro based industries, efficient management of land resources will play a critical role.
- Land resources, as defined by the **Food and Agriculture Organization (FAO)**, encompass the Earth's surface, including soil, water, vegetation, and geological features. The FAO's definition emphasises the dynamic nature of land, recognizing its integral role in ecological processes and human activities. This definition, provided by a globally recognized authority, forms the basis for understanding the complex interactions between the environment and socio-economic practices.

Plains

- **Definition:** Plains, extensive flat or gently rolling areas with low elevation, cover 43 percent of the total land area.
- **Characteristics:**
  - Rich alluvial soils, making them ideal for **agriculture** and supporting major global **food-producing regions**.
  - Dense populations often thrive in **plains** due to fertile land, accessible transportation, and conducive living conditions.
  - **Examples: Indo-Gangetic plains, the Great Plains of North America, and the European Plain.**

Mountains

- **Definition:** Mountains, elevated landforms with rugged and steep terrain, cover 33 percent of the land.
- **Role and Importance:**
  - Crucial role in regulating **climate**, acting as water reservoirs, and influencing **precipitation patterns**.
  - **Biodiversity hotspots**, hosting unique flora and fauna, and sources of valuable resources like minerals, timber, and freshwater.
  - **Examples: Himalayas, the Andes, and the Rocky Mountains.**

Plateaus

- **Definition:** Plateaus, constituting 27 percent of the total land surface of the earth, are elevated flat or gently sloping areas with steep boundaries.
- **Characteristics and Contributions:**
  - Offer a mix of characteristics from both **plains** and **mountains**, contributing to water drainage systems.
  - Serve as headwaters for rivers, valuable for **agriculture**, and house diverse ecosystems.
  - **Examples: Deccan Plateau in India and the Colorado Plateau in the United States.**

Significance of Land Resources

Land resources hold paramount significance due to their multifaceted contributions to ecological stability, human livelihoods, and economic development.

- **Importance for Biodiversity:**
  - **Land** serves as the habitat for a diverse array of flora and fauna.
  - The preservation and responsible management of **land resources** are crucial for maintaining **biodiversity**, ensuring the survival of various species and contributing to ecosystem resilience.
  - Soil composition, groundwater availability, and local climatic conditions become the basis for the utilization and development of **land resources**.
- **Role in Agricultural Productivity:**
  - Arable land is the foundation of agricultural activities, providing the space for crop cultivation.
  - The significance of land in agriculture is evident in its role as a source of food, fiber, and other essential commodities, directly impacting global food security.
  - **FAO's State of Food Security and Nutrition in the World (SOFI) 2023** highlighted that nearly 775 million people experienced hunger in 2021, mainly due to poor land management, emphasizing the pressing need for sustainable land management practices.
- **Contribution to Economic Development:**
  - **Land resources** contribute significantly to **economic activities**, with urban areas, industrial zones, and infrastructure development relying on **land**.
  - Proper **land use planning** enhances **economic growth** by providing space for businesses, housing, and transportation networks.
  - The **World Bank's** 2023 **Land Use Indicator** indicated that **land** contributes to 70% of global **GDP**, showcasing its vital role in supporting **agriculture**, industries, and urban development.
- **Ecosystem Services Provided by Land:**
  - **Land** plays a pivotal role in providing essential **ecosystem services**, with wetlands filtering water, forests regulating **climate**, and soil supporting nutrient cycling.
  - These services are critical for maintaining environmental balance and supporting life on Earth.
- **Cultural and Recreational Value of Land:**
  - Land holds cultural significance for many communities, often serving as a repository of cultural heritage and traditional practices.
  - Additionally, it provides spaces for **recreational activities**, promoting physical and mental well-being.
- **Carbon Sequestration and Climate Change Mitigation:**
  - Forests and other vegetated land play a vital role in carbon sequestration, mitigating the impacts of climate change.
  - Preserving and restoring these ecosystems are essential for global climate resilience.
- **Interactions with Water Resources:**
  - **Land** interacts closely with **water resources**.
  - Proper **land management** helps in maintaining water quality, preventing soil erosion, and sustaining water availability for various purposes.
- **Habitat for Human Settlement:**
  - **Land** is the foundation for human habitation.
  - Proper **land use planning** ensures the availability of suitable spaces for **housing**,
  - Addressing urbanization challenges, and promoting sustainable living environments.

Understanding the significance of **land resources** involves recognizing their role in supporting life, ecosystems, and economic activities. Responsible **land management** is imperative to balance human needs with environmental conservation, ensuring the sustainable use of this invaluable natural asset.

IGNITE YOUR MIND

You're on a mission to solve a crime! But the clues are hidden in soil samples. How can analyzing land use and degradation patterns help you crack the case?

Land use

Land use refers to the various ways in which land is utilised based on human activities and purposes. Land Use is the function or functions that humans apply to the land available to them or in other words the various uses the available land is put into by human beings.

Land Use Functions:

- **Variety of Uses:** It involves the various uses the available land is put into by human beings.
- **Human Activities:** Land use is based on the needs and activities of human populations.

Study of Land Use:

- **Definition:** The study of land use is the study of how the land is managed according to human needs.
- **Land Use Pattern:** The layout or arrangement of the uses of the land is referred to as the "land use pattern."

Factors Influencing Land Use:

- **Numerous Factors:** Relief features, climate, soil, population density, technical, and socioeconomic factors can influence land use.
- **Spatial and Temporal Variation:** Land utilization varies both spatially and temporally due to the ongoing interaction of physical and human factors.

Land Use in India:

- **Total Area:** India covers a total area of approximately 328.73 million hectares.
- **Surveyed Land:** Approximately 305.90 million hectares of land are covered by statistics regarding land use.
- **Unsurveyed Land:** The balance 23 million hectares remains unsurveyed and inaccessible.

Different categories of land use has been adopted in different countries but India use the land use category as proposed by the land revenue department, which are as follows

- **Forests:**
  - It is important to note that the area under actual forest cover is different from the area classified as forest. The latter is the area which the Government has identified and demarcated for forest growth. The land revenue records are consistent with the latter definition. Thus, there may be an increase in this category without any increase in the actual forest cover.
  - The area designated for forests still includes the area used for growing crops as well as grazing lands or areas that are available for grazing.
  - **Approximately 23% of the reported area** is covered by forests, a significant improvement over the 14% covered in 1950–1951.
  - The reporting area of the **forest must be 33% of the total land, per National Forest Policy 1952**.
- **Land not available for cultivation**

This class consists of **two types of land**

1. Land put to non-agricultural uses
2. Barren and uncultivable waste

1. **Land Put to Non-Agricultural Uses:** Land utilized for settlements, infrastructure, industries, and commercial purposes falls under this category, with an expansion in secondary and tertiary activities contributing to its increase.
2. **Barren and Wastelands:** Areas such as barren hilly terrains and desert lands, unfit for cultivation with current technology, are classified as wastelands. These lands increased from 41.48 to 43.56 million hectares from 200001 to 201011, comprising 14% of the total area. Gujarat, Uttar Pradesh, Bihar, Madhya Pradesh, Maharashtra, Rajasthan, Himachal Pradesh, and Andhra Pradesh have the most land in this category.

- **Area under Permanent Pastures and Grazing Lands:** Owned mostly by village panchayats or the government, these lands cover approximately 10.3 million hectares, representing 4% of the nation's total area. Himachal Pradesh leads with about one-third of its reporting area covered in pastures, while in other regions, it ranges from 4 to 10%.
- **Area under Miscellaneous Tree Crops and Groves:** Including orchards and fruit trees, this category saw a decrease from 6.97% in 19501951 to 1% in 20102011. Odisha holds the majority of this land, followed by Uttar Pradesh, Bihar, Karnataka, Andhra Pradesh, Assam, and Tamil Nadu.
- **Culturable Waste-Land:** Unused for over five years due to constraints like low water availability or soil erosion, this land comprises approximately 5% of the total area. Gujarat, Madhya Pradesh, Uttar Pradesh, and Maharashtra hold significant portions of cultivable waste land.
- **Fallow Lands:** Temporary uncultivated land, categorized as current fallow or fallow other than current fallow, covers 5% and 3% of reported areas, respectively. Rajasthan leads in fallow other than current fallow, while Andhra Pradesh has the largest portion in current fallow.
- **Net Area Sown:** Representing 0.68% of India's total reporting area, net sown area stands at 141.58 million hectares, with Rajasthan having the largest share. Punjab and Haryana exhibit high ratios of net sown area to total area, attributed to favorable factors like gentle slopes, fertile soils, and excellent irrigation facilities. Conversely,

mountainous regions and drier tracts have lesser net sown area due to rugged topography and unfavorable climates.

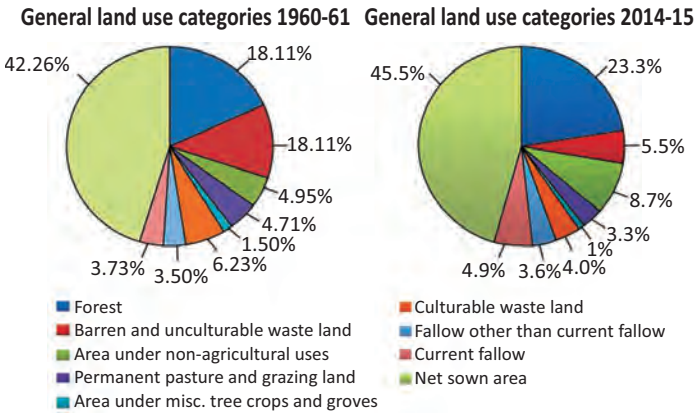


Fig. 2.11: General Land Use Categories

Land Use Change

Land-use patterns in a region are intricately tied to the economic activities that shape its development. However, the challenge arises from the fact that, unlike the dynamic nature of economic activities, land remains a fixed and finite resource in terms of its area. To comprehend the evolving relationship between the economy and land-use, it is essential to consider **three key changes that economies undergo**.

- Firstly, the expansion of the economy, measured by the value of goods and services produced, is inevitable as populations grow, income levels change, and technological advancements occur. This growth exerts increasing pressure on land, leading to the utilisation of marginal lands over time.
- Secondly, the composition of the economy transforms over time, with the secondary and tertiary sectors outpacing the growth of the primary sector, particularly agriculture. This shift is particularly pronounced in developing countries like India, where urbanisation and industrialization contribute to the conversion of agricultural land into non-agricultural uses, especially around burgeoning urban areas.
- Thirdly, while the contribution of agriculture to the overall economy diminishes, the pressure on agricultural land persists. This paradox is sustained by the slow decline in the share of the population dependent on agriculture in developing countries. The sector continues to support a significant portion of the population, even as its share in the GDP diminishes. The rising population that agriculture must feed perpetuates the demand for agricultural land, creating a complex and persistent challenge in land-use management. Addressing these evolving dynamics is crucial for achieving a harmonious balance between economic development and sustainable land utilisation.

Changes in India's Land Use (1950–51 to 2014–15): Economic Transitions, Forest Dynamics, and Agricultural Shifts

- India's land resources use has experienced many structural changes since independence.
- Increase in Non-Agricultural Uses: The highest increase is in non-agricultural land use, driven by the changing economic structure, industrial growth, and urban expansion.
- Forest Cover Increase: The increase in forest area is mainly due to the demarcation of forest land, not an actual forest cover increase.
- Current Fallow Fluctuation: Current fallow land fluctuates due to rainfall and cropping cycles.
- Net Area Sown: Recently, net area sown increased due to culturable wasteland use for agriculture, reversing a slow decline.
  - Declines include barren and wasteland, culturable wasteland, pastures and tree crops, and fallow lands, mainly due to pressure from agriculture and encroachment.

Agricultural Land-use Categories	As a percentage of Reporting Area		As a percentage of total cultivable land	
	1950-51	2014-15	1950-51	2014-15
Culturable Waste land	8.0	4.0	13.4	6.8
Fallow other than Current Fallow	6.1	3.6	10.2	6.2
Current Fallow	3.7	4.9	6.2	8.4
Net Area Sown	41.7	45.5	70.0	78.4
Total Cultivable Land	59.5	58.0	100,00	100,00

Issue Faced By The Land Resource

Land resources face various challenges such as degradation, deforestation, urbanization, and improper land use. These issues impact ecosystems, biodiversity, and agricultural productivity, demanding sustainable land management solutions.

1. Land Degradation

Land resource degradation refers to the deterioration of the quality and productivity of land, impacting its ability to support various human activities and ecosystems.

IGNITE YOUR MIND

Imagine you inherit a farm. Will you stick to traditional methods or adopt modern technology? How would your choice impact your land, profits, and the environment? How can we use land efficiently to feed a growing population while saving valuable soil? Can technologies like Drones, satellite imagery, GIS, etc. be the answer?

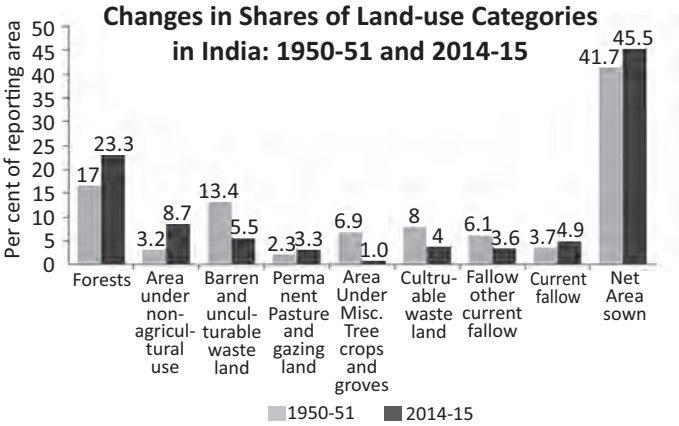


Fig. 2.12: Changes in Shares of Land use Categories

- It is a critical environmental issue with far-reaching consequences, threatening ecosystems, biodiversity, and human well-being. This degradation manifests in various forms, including soil erosion, desertification, and deforestation, each driven by distinct causes and resulting in significant impacts.
- Due to increasing population, the demands for arable land for producing food, fibre and fuel wood is also increasing. Hence there is more and more pressure on the limited land resources which are getting degraded due to over-exploitation.
- Nearly 56% of the total geographical area of the country is suffering due to land resource degradation.
- Out of 17 million hectare canal irrigated area, 3.4 million hectare is suffering from water logging and salinity. Soil erosion, water logging, salinization and contamination of the soil with industrial wastes like fly-ash, press mud or heavy metals all cause degradation of land.

Major Causes of Land Degradation:

- **Soil Erosion:**
  - Soil erosion is the natural or human-induced process where the topsoil layer is removed by factors such as water and wind. It reduces soil fertility, disrupts agricultural activities, and contributes to the overall degradation of land quality.
  - It has been estimated that more than 5000 million tonnes of topsoil is being eroded annually and 30% of total eroded mass is getting lost to the sea. It results in the loss of fertility.
  - It basically is of two types, viz. **geologic erosion and accelerated erosion**. Various factors which affect soil erosion include soil type, vegetation cover, slope of ground, soil mismanagement and intensity and amount of rainfall
- **Desertification:**
  - Desertification is the process by which fertile land becomes increasingly arid and unproductive, often resulting from prolonged land degradation, soil erosion, and climatic factors. It can lead to the transformation of once-productive areas into desert-like landscapes.
- **Deforestation:**
  - Deforestation involves the large-scale clearing of forests for purposes such as agriculture, logging, or urban development. The removal of trees reduces the protective cover on the soil, making it vulnerable to erosion, loss of fertility, and biodiversity decline.
  - **Example:** In the Amazon rainforest, large-scale deforestation for cattle ranching and agriculture has led to increased soil erosion. The removal of the forest cover disrupts the natural balance and increases vulnerability to erosion.
- **Overgrazing:**
  - Overgrazing occurs when there is excessive consumption of vegetation by livestock. This leads to the depletion of plant cover, causing soil compaction, erosion, and a decrease in land productivity. It's a common issue in areas with extensive livestock farming.
- **Improper Agricultural Practices:**
  - Unsustainable agricultural practices, including monoculture (cultivating a single crop), excessive use of chemical fertilisers and pesticides, and poor irrigation management, contribute to soil degradation. These practices diminish soil quality, impair its fertility, and lead to erosion.
  - In parts of the Indian state of Punjab, intensive rice-wheat cropping patterns, coupled with excessive groundwater extraction, have led to soil degradation and erosion.
- **Urbanisation:**
  - Rapid urbanisation involves the expansion of cities and towns, converting natural landscapes into paved surfaces. This process, known as soil sealing, disrupts the balance of ecosystems, reduces water infiltration, and contributes to the fragmentation of habitats, exacerbating land degradation.
- **Mining Activities:**
  - Mining operations, such as excavation and extraction of minerals, disturb the land, leading to soil erosion, habitat destruction, and contamination of both soil and water. Improper waste disposal from mining activities further intensifies land degradation.

IGNITE YOUR MIND

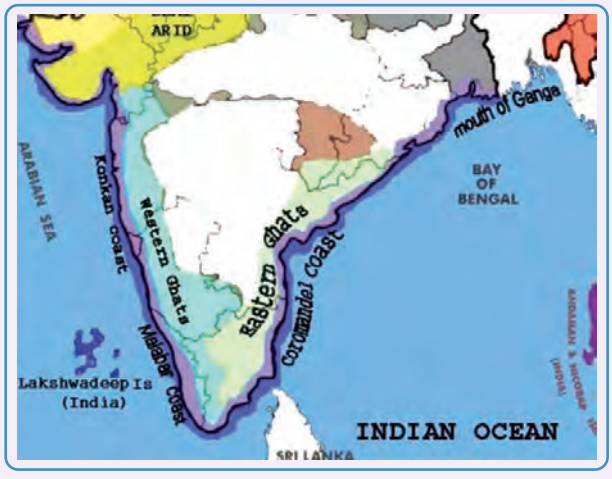
Concrete Jungle: Cities grow, forests shrink. What are the economic benefits and environmental drawbacks of urban sprawl? Can we strike a balance between development and protecting green spaces?

Addressing land degradation necessitates comprehensive strategies. Implementing sustainable agricultural practices, afforestation, and controlling deforestation are essential. Additionally, enforcing proper land-use planning, managing overgrazing, and regulating mining activities can mitigate degradation, fostering environmental resilience and biodiversity conservation.

"Case Study -Land Degradation in Eastern Ghats, India"

The Eastern Ghats face severe land degradation due to deforestation, mining, and shifting cultivation. The 2023 FAO report highlights concerns like soil erosion, nutrient depletion, and biodiversity loss, linking land degradation to poverty through reduced agricultural productivity.

Response: Indian government, NGOs, and research institutions implement programs focusing on sustainable farming, afforestation, and soil conservation. Achieving sustainable land management requires long-term commitment and coordinated efforts.



Land Degradation and Soil Erosion

The relationship between land degradation and soil erosion is intricate and interconnected, involving a dynamic interplay of various factors. Let's explore this complex relationship:

- **Soil Structure and Erosion:**
  - Healthy soil structure, with organic matter and good aggregation, prevents erosion.
  - Land degradation weakens soil structure, increasing vulnerability to erosion.
- **Water Erosion and Runoff:**
  - Altered water flow patterns from land degradation lead to increased surface runoff.
  - Runoff becomes a potent force for water erosion, exacerbating land degradation.
- **Wind Erosion and Deforestation:**
  - Deforestation, a driver of land degradation, reduces windbreak effect, increasing wind erosion.
  - Vegetation removal exposes soil to wind, transporting fine particles and contributing to degradation.
- **Feedback Loop:**
  - Land degradation and soil erosion create a feedback loop of deterioration.
  - Initial stages of degradation make land more susceptible to erosion, and erosive forces further degrade the land.
- **Climate Change and Erosion Dynamics:**
  - Climate change influences precipitation patterns, impacting erosive forces on degraded land.
  - Changes in rainfall patterns exacerbate soil erosion, adding complexity to the relationship.
- **Mitigation Strategies:**
  - Combatting land degradation requires addressing soil erosion.
  - Soil conservation, reforestation, contour ploughing, and cover crops are crucial for sustainable land management.

Understanding and managing this relationship necessitate integrated approaches considering drivers of land degradation and erosive processes. Sustainable land management, reforestation, and soil conservation are pivotal in breaking the cycle, contributing to landscape restoration.

Case study -Soil Erosion in Assam, India

- **Issue:** Severe soil erosion in Brahmaputra valley due to heavy rainfall, steep slopes, and intensive agriculture.
- **Study Findings (2022):** Over 50% of the land experiences moderate to high erosion, impacting agriculture and causing river sedimentation.
- **Contributors:** Deforestation, shifting cultivation, and inadequate soil conservation practices.
- **Impacts:** Land degradation, reduced crop yields, loss of biodiversity, and increased flood risk.
- **Response:** Assam government, with Indian Council of Agricultural Research, implements programs for soil conservation (afforestation, terracing). Ongoing efforts needed for underlying issues like poverty and farmer awareness.

Complex Relationship of Land Degradation and Desertification

"The complex relationship between land degradation and desertification involves a series of interconnected processes and feedback loops. Let's delve into the intricacies of this relationship."

- **Soil Degradation as a Precursor:**
  - Deforestation, overgrazing, improper agricultural practices, and urbanization contribute to soil degradation.
  - Land degradation often precedes desertification, compromising soil quality and fertility.
- **Reduced Vegetative Cover:**
  - Loss of vegetative cover from land degradation exposes the soil.
  - Decreased vegetation makes the land more vulnerable to conditions leading to desertification.
- **Soil Erosion and Desertification:**
  - Soil erosion, a consequence of land degradation, accelerates desertification.
  - Erosion strips away nutrient-rich topsoil, making the land less fertile and more susceptible to aridification.

- **Altered Hydrological Cycle:**
  - Land degradation disrupts the hydrological cycle, altering water runoff patterns.
  - Changes affect groundwater recharge, reducing water availability and exacerbating conditions conducive to desertification.
- **Climate Change Feedbacks:**
  - Desertification and climate change create a feedback loop.
  - Expanding deserts influence climate patterns, leading to changing precipitation regimes and increased aridity, promoting desertification.
- **Livelihood Impacts:**
  - Desertification affects livelihoods, contributing to poverty, food insecurity, and migration.
  - Loss of productive land creates social and economic challenges perpetuating the cycle of degradation.
- **Human Activities and Unsustainable Land Use:**
  - Anthropogenic activities like intensive agriculture amplify desertification risk.
  - Unsustainable land use practices, driven by short-term economic interests, contribute to ecosystem degradation.
- **Restoration Challenges:**
  - Reversing desertification is challenging due to degraded land.
  - Restoration requires comprehensive strategies, including reforestation, sustainable land management, and community involvement.

Expansion of Thar Desert, India

The Thar Desert in western India is one of the world's largest and most rapidly expanding deserts. A 2021 report by the United Nations Convention to Combat Desertification (UNCCD) attributed this desertification to factors like overgrazing, unsustainable groundwater use, and climate change. The report highlighted the impact on local communities, with loss of livelihoods, increased dust storms, and water scarcity becoming major challenges.

Impacts: Land degradation, loss of productivity, water scarcity, dust storms, migration.

Response: The Indian government has launched several initiatives to combat desertification in the Thar Desert, including afforestation programs, rainwater harvesting projects, and promoting alternative livelihoods for communities. The UNCCD is also collaborating with local stakeholders to implement sustainable land management practices.

Understanding and addressing the complex relationship between land degradation and desertification necessitate holistic approaches. Sustainable land management, conservation practices, and international cooperation are essential for mitigating impacts and promoting restoration.

IGNITE YOUR MIND

Dust Bowl Dilemma: Imagine a dust storm blowing over your town, caused by land degradation. What are the causes of this problem, and how can we prevent it? What are the social and economic consequences?

Steps Taken to Resolve Land Degradation and Desertifications

Global Measures

- **United Nations Convention to Combat Desertification (UNCCD):**
  - The UNCCD is a legally binding international agreement aimed at combating desertification and mitigating the effects of drought. It promotes sustainable land management practices, fosters international cooperation, and emphasizes the active involvement of local communities. The Convention encourages the adoption of measures to prevent, control, and reverse land degradation, emphasizing a holistic and integrated approach to land management.
- **Sustainable Development Goals (SDGs), Goal 15: Life on Land:**
  - Goal 15 of the SDGs focuses on protecting, restoring, and promoting sustainable use of terrestrial ecosystems. It includes specific targets related to combating desertification, restoring degraded land, and ensuring the conservation of biodiversity. The SDGs provide a comprehensive framework for global efforts to address land degradation and promote sustainable land management practices.
- **Bonn Challenge:**
  - The Bonn Challenge is a global effort to restore 150 million hectares of degraded and deforested land by 2020 and 350 million hectares by 2030. It emphasizes the restoration of ecosystems for multiple benefits, including climate change mitigation, biodiversity conservation, and sustainable livelihoods. The initiative encourages countries to make voluntary commitments to restore degraded land and forests.
- **Global Soil Partnership (GSP):**
  - The GSP is a collaborative initiative led by the Food and Agriculture Organization (FAO) that aims to improve global soil governance and promote sustainable soil management. It addresses issues related to soil erosion, nutrient depletion, and degradation through knowledge sharing, capacity building, and the development of sustainable soil management practices.
- **Land Degradation Neutrality (LDN):**
  - LDN is a target under the UNCCD that seeks to achieve a balance between the amount of land degraded and the amount of land restored. Countries committed to

LDN work towards achieving no net loss of healthy and productive land.

- This approach encourages sustainable land management practices, restoration efforts, and the implementation of measures to offset any ongoing land degradation.India has pledged to achieve LDN by 2030 and is actively involved in setting national LDN targets and action plans.
- Initiatives like the "The Great Green Wall of India" aim to restore 5 million hectares of degraded land in the Thar Desert, promoting afforestation and sustainable land management practices.

These global measures collectively emphasise the importance of international cooperation, sustainable land management practices, and the engagement of local communities in addressing the challenges of land degradation and desertification.

National Measures

India has implemented various measures to combat land degradation and desertification. Here are five key steps taken in this direction:

❑ **National Action Plan on Climate Change (NAPCC):**

- Under the NAPCC, the National Mission for Sustainable Agriculture (NMSA) was launched to promote climate-resilient agricultural practices. This mission addresses issues of soil health, water use efficiency, and the adoption of conservation agriculture to mitigate the impacts of climate change and combat land degradation.

❑ **Pradhan Mantri Krishi Sinchayee Yojana (PMKSY):**

- PMKSY aims to improve water use efficiency through the development of water resources and efficient water management practices. This includes promoting water-saving irrigation techniques and rainwater harvesting to enhance soil moisture and reduce the risk of land degradation.

❑ **Integrated Watershed Management Program (IWMP):**

- IWMP focuses on watershed development to enhance soil and water conservation. It includes afforestation, check dams, and contour bunding to control soil erosion and improve water retention in rain-fed areas. The program involves community participation for sustainable land management.

❑ **National Mission on Sustainable Agriculture (NMSA):**

- NMSA, part of the National Action Plan on Climate Change, aims to make agriculture more resilient to climate change and promote sustainable land management practices. It includes initiatives for soil health improvement, water use efficiency, and the adoption of agro-ecological practices.

❑ **Soil Health Card Scheme:**

- The Soil Health Card Scheme provides farmers with information on the nutrient status of their soil. By promoting balanced and judicious use of fertilizers based on soil health, the scheme contributes to sustainable land management and prevents soil degradation.

❑ **Afforestation and Reforestation Programs:**

- India has initiated various afforestation and reforestation programs to increase green cover and combat desertification. Initiatives like the Green India Mission and the National Afforestation Programme (NAP) focus on restoring degraded ecosystems and improving biodiversity.

❑ **National Mission for a Green India (GIM):**

- GIM aims to increase forest and tree cover, restore degraded ecosystems, and enhance biodiversity. The mission encourages community participation and sustainable land management practices to achieve its goals.

These steps reflect India's commitment to addressing land degradation and desertification through a combination of sustainable agriculture, watershed management, afforestation, and community involvement.

Best Practices

❑ **Agroforestry in Khammam, Telangana:**

- In Khammam, Telangana, an agroforestry initiative has rejuvenated degraded land. Integrating trees with traditional crops enhances biodiversity, improves soil fertility, and prevents erosion. The agroforestry model not only restores the ecological balance but also provides additional income sources for farmers. By diversifying land use, this approach contributes to sustainable land management and rural livelihood improvement.

❑ **Banni Grasslands Conservation in Gujarat:**

- The Banni Grasslands in Gujarat faced extensive land degradation due to overgrazing and invasive species. A collaborative effort involving local communities, NGOs, and government agencies implemented conservation strategies. Sustainable livestock management practices were introduced, and invasive species were controlled to restore the grasslands. The project not only revived the ecosystem but also empowered local communities through participatory decision-making.

❑ **Afforestation in Chhattisgarh's Surguja District:**

- Surguja, Chhattisgarh, addressed deforestation and land degradation through extensive afforestation initiatives. The project focused on planting native tree species, employing community participation, and promoting sustainable forestry practices. This not only restored degraded lands but also enhanced biodiversity and ecosystem services. Surguja's success showcases the positive impact of afforestation in mitigating environmental challenges, contributing to sustainable land management, and improving the overall ecological health of the region.

- **Bamboo Plantations in Mizoram:**
  - Mizoram successfully harnessed bamboo plantations for both ecological restoration and economic development. Bamboo, a versatile and fast-growing plant, aids in soil conservation, watershed management, and erosion control. Through community-based bamboo cultivation, Mizoram not only restored degraded landscapes but also generated sustainable livelihoods. The initiative emphasised the role of bamboo in promoting sustainable land management.

Alleviating Human Misery: Effective Land & Water Management

- **Natural Disaster Mitigation:** Effective land management practices, such as afforestation, soil erosion control, and watershed management, can mitigate the impact of natural disasters like floods, droughts, and landslides. This protects communities from loss of life, property damage, and displacement, reducing human suffering during such events.
- **Agricultural Productivity:** Proper land and water management techniques, such as efficient irrigation systems and soil conservation practices, can enhance agricultural productivity. This ensures food security, reduces hunger, and improves the livelihoods of farmers, thereby reducing poverty and malnutrition.
- **Ecosystem Health:** Proper management of land and water resources helps maintain the health and biodiversity of ecosystems. Healthy ecosystems provide essential ecosystem services, such as clean air, clean water, and pollination, which are vital for human well-being. Preserving ecosystems also supports livelihoods dependent on natural resources, such as fishing and ecotourism.
- **Water Availability:** By managing water resources sustainably, through measures like rainwater harvesting, groundwater recharge, and water recycling, communities can ensure a consistent and reliable water supply for drinking, sanitation, and irrigation purposes. This reduces the occurrence of water scarcity-related issues, such as waterborne diseases and conflicts over water resources.
- **Climate Change Resilience:** Sustainable land and water management practices contribute to climate change resilience by reducing greenhouse gas emissions, enhancing carbon sequestration, and improving ecosystem resilience to climate impacts. This helps communities adapt to changing climatic conditions and reduces vulnerability to climate-related disasters.

In conclusion, the sustainable management of land and water resources is paramount for the well-being of our planet. As essential components of our ecosystem, these resources play a vital role in supporting life, agriculture, and various industries. Conservation efforts, responsible land use planning, and efficient water management are crucial to ensure their availability for current and future generations. By adopting sustainable practices, promoting environmental awareness, and fostering international cooperation, we can collectively safeguard these invaluable resources, preserving the balance of our ecosystems and promoting a healthier, more resilient planet.

Mineral Resources

3

MINERAL RESOURCES

- Minerals are naturally occurring combinations of elements with specific physical and chemical properties. They are important constituents of human beings, animals, vegetation and rocks. They are unevenly distributed across the globe. Some minerals are found in areas which are not easily accessible such as the Arctic ocean bed and Antarctica.
- Minerals are formed across millions of years by natural processes in different types of geological environments. Various stages in the economic development of human civilization were named after minerals from the Stone Age, Copper Age, Bronze Age and Iron Age.
- Minerals play a crucial role in facilitating industrial development within a nation. India is blessed with an abundance of minerals having economic significance. Notable examples include coal, iron ore, manganese, bauxite, and mica. However, the reserves of certain minerals like petroleum and some non-ferrous metals such as copper, lead, zinc, tin, and graphite, are insufficient to meet the growing demands of the country.

Global Distribution of Minerals

The global distribution of minerals is characterized by significant variations in resource availability across different regions, influenced by geological, historical, and economic factors. Here's a brief note highlighting key aspects:

- **Geological Factors:** Mineral distribution is heavily influenced by geological processes such as plate tectonics, volcanic activity, and weathering. Different geological formations give rise to diverse mineral deposits.
  - For example, **sedimentary basins** are associated with **oil and natural gas** reserves, while **volcanic regions** may host valuable metal deposits like **gold and copper**.
- **Historical Exploration and Exploitation:** Regions with a long history of mining and extraction activities often have well-established mining infrastructure and expertise. Additionally, colonial-era exploration and exploitation have left lasting legacies, with some countries still dominating the production of certain minerals due to historical factors.
- **Economic Considerations:** Economic factors such as production costs, labor availability, and market demand play a crucial role in mineral distribution. Countries with abundant resources and favorable production conditions often become major players in global mineral markets. Additionally, geopolitical considerations, trade policies, and investment climates influence the flow of minerals across borders.
- **Regional Concentrations:** Certain regions are known for their abundance of specific minerals.
  - For example, the **Middle East** is renowned for its vast **oil reserves**,
  - while **southern Africa** is a major source of **diamonds**,
  - countries like **Australia and Brazil** are significant producers of **iron ore and bauxite**, respectively, due to their rich mineral endowments.
- **Technological Advancements:** Technological advancements have enabled the discovery and extraction of minerals from previously inaccessible or uneconomical deposits. Remote sensing, geophysical surveys, and advanced mining techniques have expanded the scope of mineral exploration and production, leading to the discovery of new deposits in diverse geographical settings.
- **Environmental and Social Implications:** The extraction and processing of minerals often have environmental and social implications. Mining activities can lead to habitat destruction, water pollution, and social conflicts over land rights and resource ownership. Sustainable mining practices and responsible resource management are increasingly emphasized to mitigate these impacts.

The global distribution of minerals is complex and multifaceted, shaped by geological, historical, economic, technological, and environmental factors.

Types of Minerals

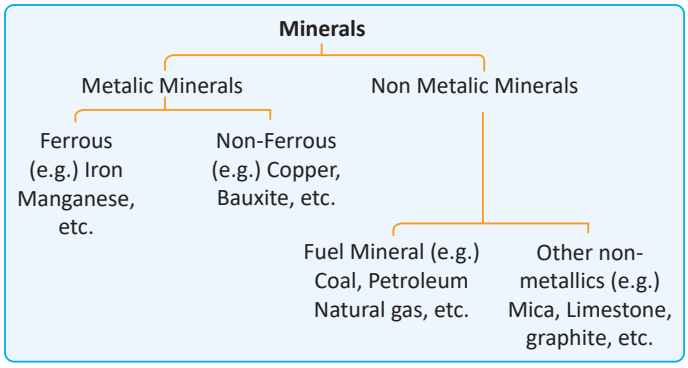

Minerals
Metalic Minerals
Non Metalic Minerals
Ferrous (e.g.) Iron Manganese, etc.
Non-Ferrous (e.g.) Copper, Bauxite, etc.
Fuel Mineral (e.g.) Coal, Petroleum Natural gas, etc.
Other non-metallics (e.g.) Mica, Limestone, graphite, etc.

Fig. 3.1: Types of Minerals

Minerals can be categorized into two primary groups based on their chemical and physical properties: **Metallic** and **Non-metallic** minerals.

- **Metallic minerals,** especially ferrous and non-ferrous, are crucial for the production of metals that are widely used in various industries.
- **Non-metallic minerals,** on the other hand, contribute to construction, manufacturing, and other specialized applications, such as gemstone production and energy generation.

Metallic Minerals

Metallic minerals serve as sources of metals and play a crucial role in advancing the metallurgical industry. Examples of metallic minerals include iron ore and bauxite, which produce metals and are characterized by their metallic shine or luster.

Classification of Metallic Minerals

- **Ferrous minerals:** It encompasses those with iron content, such as iron ore, manganese, and chromites. These minerals constitute approximately three-fourths of the total value of metallic mineral production, laying a robust foundation for metallurgical sectors, particularly iron, steel, and alloys. India enjoys a favorable position concerning ferrous minerals, both in terms of reserves and production.
- **Non-ferrous minerals:** These lack iron content and include minerals like copper and bauxite. India, with the exception of bauxite, is relatively less endowed with non-ferrous metallic minerals.

Non-Metallic Minerals

Non-metallic minerals can be either organic or inorganic in origin and do not have a metallic luster and are not a source of metals.

Classification of Non-Metallic Minerals

- They are further divided into two categories based on their origin: **Mineral fuels and other non-metallic minerals**.
- India possesses a variety of non-metallic minerals, with commercially significant ones including limestone, dolomite, mica, kyanite, sillimanite, gypsum, and phosphate. These minerals find applications in industries such as cement, fertilizers, refractories, and electrical goods.
- **Mineral fuels:** These are also known as fossil fuels, are organic in origin and are derived from buried animal and plant life, with coal and petroleum being prominent examples.
- **Other Non-Metallic Minerals:** These in contrast, are inorganic, including mica, limestone, and graphite.

Characteristics of Minerals

Characteristic	Metallic Minerals	Non-Metallic Minerals
Luster	Shiny, reflective surface (metallic)	Vitreous, pearly, silky, or dull luster
Conductivity	Good conductor of heat and electricity	Poor conductor of heat and electricity
Malleability	Can be hammered into thin sheets	Generally brittle, tends to fracture
Ductility	Can be drawn into thin wires	Brittle, does not deform easily
Appearance	Opaque	Transparent or translucent in some cases
Density	High density	Lower density
Thermal Stability	High melting points, thermally stable	Lower melting points, may decompose
Transparency/ Translucency	Usually opaque	Transparent or translucent in some cases
Hardness	Varies	Varies
Uses	Often used in metallurgy, construction	Construction, industry, energy gemstones.

Extraction of Minerals

The process of taking out minerals from rocks buried under the earth's surface is called **mining**.

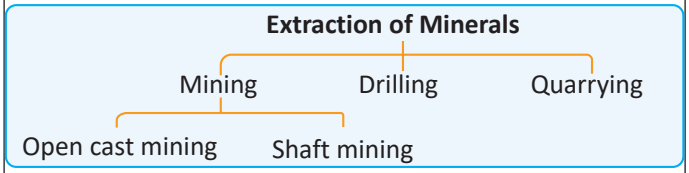


Fig. 3.2: Extraction of Minerals

- Minerals that lie at shallow depths are taken out by removing the surface layer; this is known as **open-cast mining.**
- Deep bores, called shafts, have to be made to reach mineral deposits that lie at great depths. This is called **shaft mining**.
- Petroleum and natural gas occur far below the earth's surface. Deep wells are bored to take them out, this is called **drilling**.
- Minerals that lie near the surface are simply dug out, by the process known as **quarrying**.

Metallic Minerals

Ferrous Minerals

1. Iron Ore

Iron ore is a critical raw material for the production of iron and steel. The choice of iron ore used in steelmaking depends on factors such as the iron content, impurities present, and the specific requirements of the steel production process. Hematite and magnetite are the primary ores used for direct ironmaking, while goethite and limonite are often processed to produce concentrates suitable for iron and steel production. Siderite is less commonly used due to its lower iron content.

Types of iron ore(based on iron content)

- **Magnetite (Fe_3O_4):**
  - Magnetite has a higher iron content compared to hematite, typically around 70% to 72%. It is magnetic, distinguishing it from other iron ores.
  - Magnetite can appear as black to brownish-black crystals.

❑ **Hematite (Fe_2O_3):**

- Hematite is one of the most abundant and economically important iron ores. It has a high iron content, typically around 50% to 60%.
- Hematite often appears as a silver to black metallic-looking mineral with a red streak.

❑ **Limonite ($FeO(OH)\cdot nH_2O$):**

- Limonite is a hydrated iron ore and is often formed by the weathering of other iron-bearing minerals. It contains **40% to 60%** pure iron.
- It can have a range of colors, including brown, yellow, and black.
- Limonite often occurs in the form of amorphous or earthy masses.

❑ **Siderite ($FeCO_3$):**

- Siderite is a carbonate iron ore. It has a lower iron content compared to hematite and magnetite, typically around 48%.
- Siderite can range in color from brown to black.

Goethite (FeO(OH))

- ❑ Goethite is a weathering product of other iron-bearing minerals.
- ❑ It usually has a brown to yellow-brown color and a high water content.
- ❑ It is composed of about 80 to 90 percent Fe_2O_3 and approximately 10 percent water.
- ❑ When dehydrated, goethite forms hematite, while upon hydration, goethite becomes limonite.

Global Distribution of iron ore

❑ **Australia (Oceania): Australia is a leading global producer of iron ore.**

- Major iron ore regions include the Pilbara in Western Australia, where large-scale mining operations, including Rio Tinto and BHP, are located.

❑ **South America**

- **Brazil:** Brazil is another significant player in the global iron ore market. **The Carajas Mine in the state of Para** is one of the largest iron ore mines in the world.

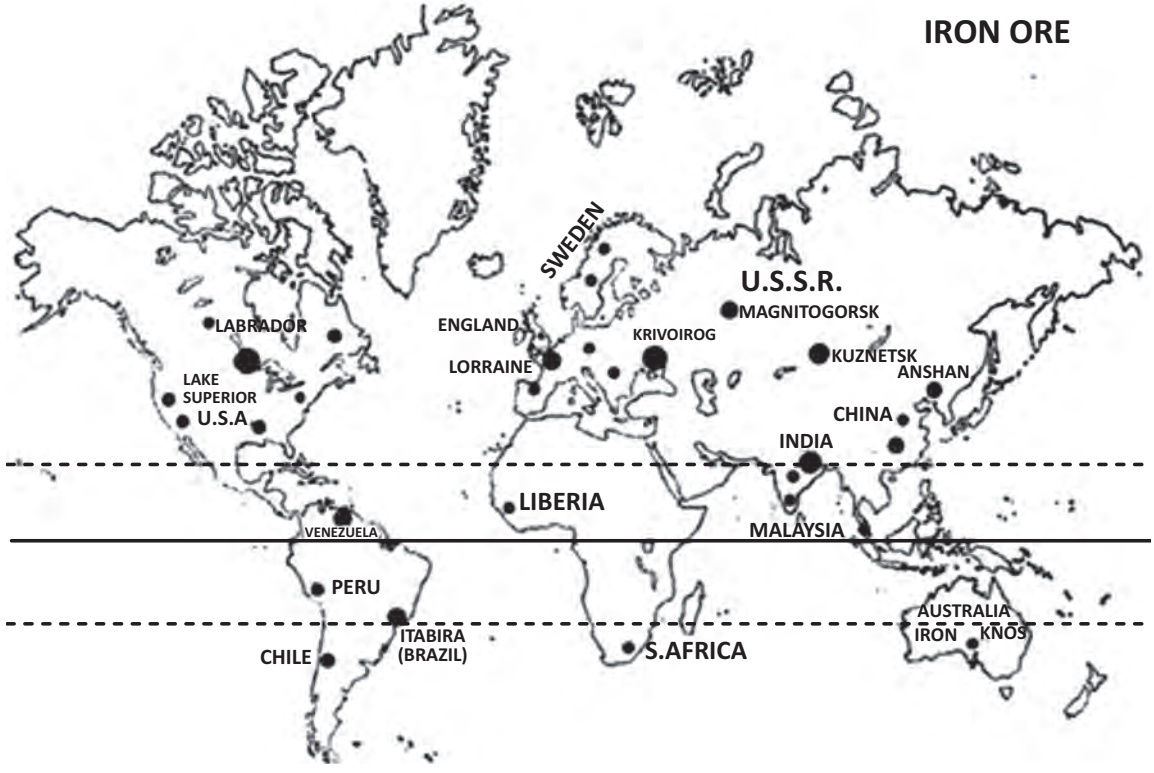


Fig. 3.3: Iron Ores World Distribution"

❑ **Asia**

- **China:** While China is a major consumer of iron ore, it also produces a significant amount. Iron ore deposits are found in various provinces, including Hebei, Liaoning, **and Anhui.**
- **India:** Major iron ore-producing states include **Odisha, Jharkhand, and Chhattisgarh.**

❑ **Africa**

- **South Africa:** South Africa is an important supplier of iron ore, particularly high-grade hematite. **The Sishen Mine in the Northern Cape** is a prominent iron ore producer.

❑ **North America**

- **Canada:** Canada has significant iron ore deposits, with production concentrated in the Labrador Trough in Quebec and Labrador.
- **United States:** Iron ore is mined in regions such as the Mesabi Range in Minnesota and the Lake Superior District in Michigan.

- **Europe**
  - **Sweden:** Sweden is a major iron ore producer in Europe, with the Kiruna Mine being one of the largest underground iron ore mines globally.
  - **Ukraine:** Ukraine has substantial iron ore deposits, with mining operations concentrated in the Kryvyi Rih Basin.
  - **Russia:** Russia has large iron ore reserves in regions such as the Kursk Magnetic Anomaly. Major mining operations are located in the Urals and the Kola Peninsula.

Reserves

- **Australia has the world's largest reserves of iron ore** with roughly 51000 million tonnes comprising a share of 28.5%.
- Other countries with large reserves include Brazil, Russia, China, Ukraine, Canada and India.

World reserves of crude iron ore, by country, 2021

Ranking	Country	Million tonnes	Percentage of total
1	Australia	51,000	28.5%
2	Brazil	34,000	19.0%
3	Russia	25,000	13.9%
4	China	20,000	11.2%
5	Ukraine	6,500	3.6%
Top 5 Producers of iron ore in 2023: Australia > Brazil > China > India > Russia			

Consumption

- **China** is the world's largest consumer of iron ore, despite being only the third largest iron-producing country.

Applications

- **Steel Production:** Iron ore is primarily used in the production of steel. It serves as the main ingredient in the blast furnace process, where iron ore is melted and converted into pig iron, which is then further refined to produce steel.
- **Construction:** Steel derived from iron ore is extensively used in construction projects. It is employed in the construction of buildings, bridges, roads, railways, dams, and other infrastructure due to its strength, durability, and versatility.
- **Automotive Industry:** Iron and steel are essential materials in the automotive sector. They are used to manufacture vehicle components such as chassis, engine parts, body panels, and structural reinforcements, contributing to the strength, safety, and performance of automobiles.
- **Machinery and Equipment:** Iron and steel are integral to the production of machinery and equipment used in various industries. From heavy machinery in manufacturing and construction to precision tools and appliances, iron ore-derived steel is indispensable in the fabrication of diverse equipment.
- **Shipbuilding:** Iron ore is utilized in shipbuilding for constructing the hulls, decks, and other structural components of ships and vessels. Steel's high tensile strength and corrosion resistance make it suitable for maritime applications.
- **Infrastructure and Transportation:** Iron ore-derived steel is vital for infrastructure development and transportation systems. It is used in the construction of railways, pipelines, ports, airports, and transportation vehicles such as trains and trucks, facilitating the movement of goods and people.

2. Manganese

- The mining of manganese ores is usually done in open pits. Some ores are upgraded by washing, and undersized ores can be agglomerated by sintering. Several processes have been developed for mining seafloor nodules, but they cannot compete economically with the ready exploitation of high-grade terrestrial deposits.
- Pure manganese is produced by hydrometallurgical and electrolytic processes, while ferromanganese and silicomanganese are produced by the smelting of ores in a blast furnace or, more commonly, in an electric furnace.
- The demand for manganese is driven by its use in the production of steel and other alloys, making it a crucial industrial mineral.

Types of Manganese Ore

The most important manganese ores are the oxides pyrolusite **(MnO_2)**, romanechite, manganite **(MnOOH)**, and hausmannite **($Mn^{2+}Mn^{+2}{}_2O_4$)** and the carbonate ore rhodochrosite **($MnCO_3$)**. Rhodonite and braunite, both silicate ores, are frequently found with the oxides. Only ores containing greater than 35 percent manganese are considered commercially exploitable.

A relatively abundant metal, manganese is widely distributed throughout Earth's crust. In addition to terrestrial sources, manganese is present in nodules that are distributed widely over the seafloor. Higher-grade nodules contain 10 to 20 percent manganese along with significant amounts of cobalt, copper, and nickel.

Global Distribution of Manganese

Manganese deposits are distributed globally, with significant reserves found in various countries. The global distribution of manganese is influenced by geological processes and historical mining activities.

- **Africa:** South Africa (Kalahari Basin), Gabon (Moanda deposit), Ghana (Nsuta and Tarkwa mines) etc.
- **Asia:** China (Guangxi and Hunan provinces), India (Odisha and Karnataka)
- **Australia:** Groote Eylandt region, Woodie Woodie and Bootu Creek mines
- **South America:** Brazil (Carajás region),
- **Europe:** Russia (Urals and Siberia regions), Ukraine (Nikopol basin)
- **North America:** Mexico (Chiapas and Hidalgo regions)

Production and consumption

- **Top Producers of manganese (2022):** South Africa > Gabon > Australia > China > Ghana > India
- **Top Consumers of manganese (2022):** China > India > United States > Japan > South Korea

Applications

- **Steel Production:** Manganese is a crucial alloying element in steel production. It improves the strength, hardness, and workability of steel. High-manganese steels are used in construction, automotive, and manufacturing industries.
- **Battery Production:** Manganese is used in the production of batteries, particularly in alkaline and zinc-carbon batteries. It enhances the performance and lifespan of batteries.
- **Ferroalloys:** Manganese is a key component in the production of ferromanganese and silicomanganese, which are essential ferroalloys used in the steelmaking industry to deoxidize and desulfurize steel.
- **Chemical Industry:** Manganese compounds find applications in the chemical industry. Manganese dioxide is used as a catalyst in the production of chemicals, such as the oxidation of organic compounds.
- **Water Treatment:** Manganese compounds are used in water treatment processes to remove impurities. Manganese greensand is a commonly used filtration medium for water purification.
- **Fertilizers:** Manganese is an essential micronutrient for plants. Manganese compounds are used as fertilizers to enhance plant growth and development.
- **Ceramics and Glass Production:** Manganese dioxide is used as a decolorizing agent in the glass industry. It helps remove color impurities and creates clear glass. Manganese compounds are also used in ceramics and enamels.

Non-Ferrous Minerals

Non-Ferrous minerals are those minerals which do not contain iron or ferrous component. They find applications in a wide range of industries like automotive industry, aerospace industry, electronics industry, construction industry, etc.

1. Copper

- Copper (Cu) ore is a naturally occurring mineral deposit that contains copper in varying concentrations. It is an important industrial metal that has been used by human civilizations for thousands of years due to its **excellent electrical and thermal conductivity, high ductility, and resistance to corrosion**. Copper is widely used in various applications, including electrical wiring, plumbing, construction, transportation, and electronics, making it a critical component of modern society.
- Copper ore is typically found in the Earth's crust in the form of copper minerals, such as **chalcopyrite, bornite, malachite, and chalcocite**, among others. The formation of copper ore deposits involves complex geological processes, including hydrothermal activity, magmatic intrusions, and weathering of rocks. Copper ore deposits are found in various types of geologic environments, including **porphyry deposits, skarn deposits, sedimentary deposits, and volcanogenic massive sulfide deposits**, among others.
- Mining and extraction of copper ore involve various methods, such as **open-pit mining, underground mining,** and **in-situ leaching,** depending on the type and location of the deposit. After extraction, copper ore is processed and beneficiated to obtain copper concentrates, which are then further refined to produce high-quality copper products.

Major types of copper ore

- **Chalcopyrite ($CuFeS_2$):** Chalcopyrite is the most prevalent and economically significant copper ore. It appears as brassy yellow crystals and often contains iron sulfides.
- **Bornite (Cu_5FeS_4):** Known as "peacock ore" due to its colorful iridescence, bornite is a sulfide mineral with a high copper content. It typically exhibits shades of blue and purple.
- **Malachite ($Cu_2(CO_3)(OH)_2$):** Malachite is a green carbonate mineral formed through the weathering of copper minerals. Its distinctive green color and banded patterns make it easily recognizable.
- **Azurite ($2CuCO_3{\cdot}Cu(OH)_2$):** Azurite is a blue carbonate mineral, often found alongside malachite. It forms as a result of copper oxidation and can display deep blue hues.
- **Cuprite (Cu_2O):** Cuprite is a red oxide mineral where copper is in its monovalent state (Cu+). It occurs as red to brown crystals and is commonly found in the oxidized zones of copper deposits.

Global distribution of copper

Distribution of mine production of copper worldwide in 2021, by country

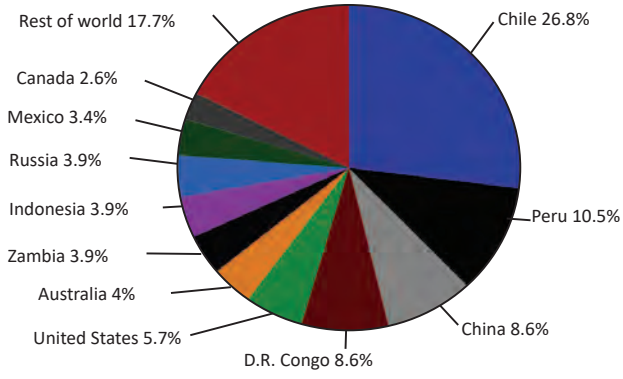


Fig. 3.4: Global Production of Copper Mines

- **Chile:** Chile is the **world's largest producer of copper,** accounting for a significant portion of the global supply. The Andes Mountains in Chile are home to several large copper mines, such as Escondida, Collahuasi, and El Teniente.
- **Peru:** Peru is another major copper-producing country, with significant deposits in the Andes Mountains. Prominent mines include Cerro Verde and Antamina.

- **China:** China is a major consumer and producer of copper. While it has substantial domestic copper resources, it also imports significant quantities to meet its growing demand. Key mining regions include Jiangxi, Inner Mongolia, and Xinjiang.
- **United States:** The United States has copper deposits in various states, including Arizona, Utah, New Mexico, and Nevada. The Bingham Canyon Mine in Utah is one of the largest open-pit copper mines globally.
- **Australia**: Australia is a significant copper producer, with major mines in South Australia and Queensland. The Olympic Dam mine is a notable copper and uranium resource.

Other copper producing regions

- **Indonesia**: Indonesia has copper deposits on the island of Papua, with the Grasberg mine being one of the largest copper and gold mines globally.
- **Congo (Kinshasa):** The Democratic Republic of the Congo has substantial copper resources in the Katanga region. The Tenke Fungurume mine is a notable copper producer.
- **Zambia**: Zambia is a major copper-producing country in Africa, with mines such as the Konkola Copper Mines contributing significantly to global copper output.
- **Canada**: Canada has copper deposits in regions such as British Columbia and Ontario. The Highland Valley Copper mine in British Columbia is one of the largest in the country.
- **Russia**: Russia has copper resources in regions like the Ural Mountains and the Siberian region. The Udokan deposit is one of the largest copper deposits in Russia.

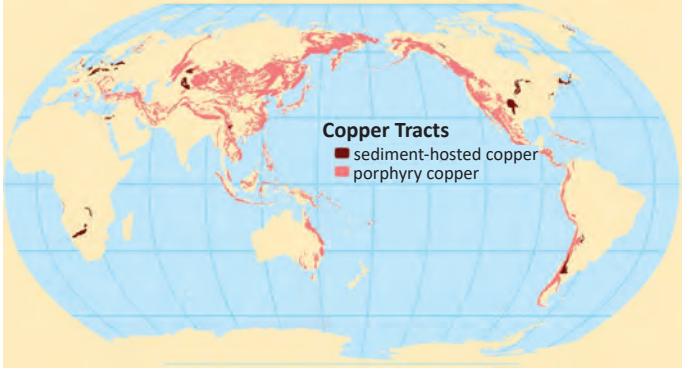


Fig. 3.5: Global Distribution of Copper Map

Applications

- **Electrical Wiring and Electronics:** Copper is highly conductive and is widely used in electrical wiring, cables, and electronics. It is an essential component in power transmission and distribution systems, circuitry, motors, transformers, and printed circuit boards due to its excellent electrical conductivity and thermal properties.
- **Construction and Infrastructure:** Copper is utilized in the construction industry for plumbing, roofing, gutters, and architectural elements. It is valued for its corrosion resistance, durability, and aesthetic appeal. Copper pipes, fittings, and fixtures are commonly used in residential, commercial, and industrial buildings.
- **Industrial Machinery and Equipment:** Copper is employed in the manufacturing of industrial machinery, equipment, and tools. It is used in heat exchangers, boilers, valves, bearings, and gears due to its excellent thermal conductivity, corrosion resistance, and machinability.
- **Transportation:** Copper is utilized in the automotive, aerospace, and marine industries for various applications. It is used in radiators, heat exchangers, brake systems, electrical components, and wiring harnesses in vehicles and aircraft due to its high conductivity, strength, and corrosion resistance.
- **Renewable Energy:** Copper plays a crucial role in renewable energy technologies such as solar power and wind energy. It is used in photovoltaic cells, solar panels, wind turbines, and electrical grid systems due to its conductivity and durability, facilitating the generation, transmission, and storage of clean energy.

2. Chromium

Chromium is an essential element in many industrial processes, including stainless steel production, alloy manufacturing, and electroplating. It is also used in the production of refractory materials, pigments, and chemicals. Chromium's ability to resist corrosion and its high melting point make it a valuable element in numerous applications.

Major types of chromium ore

- **Chromite ore ($FeCr_2O_4$):** Chromium primarily occurs as **chromite ore ($FeCr_2O_4$),** and its extraction is essential for the production of ferrochrome, an alloy used in the production of stainless steel.
  - Chromite is often found in **ultramafic rocks** and is associated with other minerals like **olivine, serpentine, and pyroxenes.**

Global distribution of chromium

- **South Africa:** South Africa is a **major producer of chromium**, hosting some of the world's largest chromite deposits. The Bushveld Igneous Complex in the country is known for its rich chromium resources.
- **Kazakhstan:** Kazakhstan is another significant producer of chromium, with substantial reserves of chromite. The country's chromite deposits are mainly located in the Aktobe region.
- **India:** India has significant chromite deposits, particularly in the states of Odisha, Karnataka, and Maharashtra. The **Sukinda Valley in Odisha** is a major chromium-producing region.
- **Turkey:** Turkey has notable chromium resources, and the country's chromium production is concentrated in areas like Eskisehir and Elazig.
- **Finland:** Finland has chromite deposits, and the Kemi Mine in northern Finland is a notable producer of chromium.

Production and consumption

- **Top Producers of chromium (2022):** South Africa > Turkey > Kazakhstan > India > Finland
- **Top Consumers of chromium (2022):** China > USA > EU > India > Japan

Applications

- **Stainless Steel Production:** Chromium is a crucial alloying element in the production of stainless steel. It imparts corrosion resistance, durability, and a shiny appearance to stainless steel products, making it suitable for applications in construction, architecture, automotive manufacturing, appliances, and kitchenware.
- **Metal Plating and Surface Finishing:** Chromium plating, also known as chrome plating, is used to provide decorative and protective finishes to metal surfaces. It enhances the appearance of products, improves corrosion resistance, and provides wear resistance in applications such as automotive parts, plumbing fixtures, furniture, and consumer electronics.
- **Alloy Production:** Chromium is used as an alloying element in the production of various alloys, including nickel-chromium alloys (e.g., Inconel) and ferrochromium alloys. These alloys exhibit high temperature strength, corrosion resistance, and oxidation resistance, making them suitable for aerospace, industrial, and high-temperature applications.
- **Chemical Industry:** Chromium compounds are utilized in the chemical industry for various applications. Potassium dichromate and sodium dichromate are used in the production of pigments, dyes, and tanning agents. Chromium salts are also used in the manufacturing of wood preservatives, leather tanning, and the production of specialty chemicals.
- **Refractory Materials:** Chromium oxide is used in the production of refractory materials, which are resistant to high temperatures and harsh environments. Chromium-based refractories are used in kilns, furnaces, and industrial reactors in sectors such as steelmaking, glass manufacturing, and petrochemical processing.
- **Aerospace and Defense:** Chromium coatings and alloys are used in aerospace and defense applications due to their high strength, corrosion resistance, and heat resistance. Chromium-plated components are used in aircraft components, missile systems, and military hardware to enhance performance and durability.

3. Nickel

- **Nickel** is a silvery-white metal with a relatively high melting point and excellent corrosion resistance.
- **The** extraction and processing methods for these ores can differ significantly. **Sulfide ores** are generally processed through **conventional mining and milling methods,** followed by smelting, whereas **lateritic ores** are often processed through a combination of **leaching and solvent extraction methods** due to their low nickel content and high levels of impurities.

Global distribution of Nickel

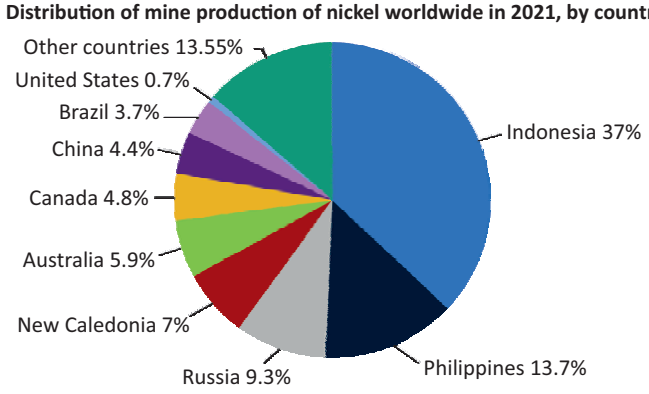


Fig. 3.6: Global Production of Nickel

Applications of Nickel:

1. **Alloying** - Nickel can form alloys with steels, Coppers, irons, chromium, aluminum, cobalt, lead, silver, gold and other ele-ments to produce stainless steel, cast iron, and other alloys.
2. **Coatings** - It primarily refer to electroplating of nickel, which is then used to provide hard-wearing decorative and engineering coatings as 'nickel-plating', 'electroless nickel coating' or 'electroforming'.
3. **Battery** - Nickel is an essential part of several rechargeable battery systems. these batteries are used in electronics, transport, power tools and emergency power supply. The most prominent component is the nickel-metal hydride (NIMH).

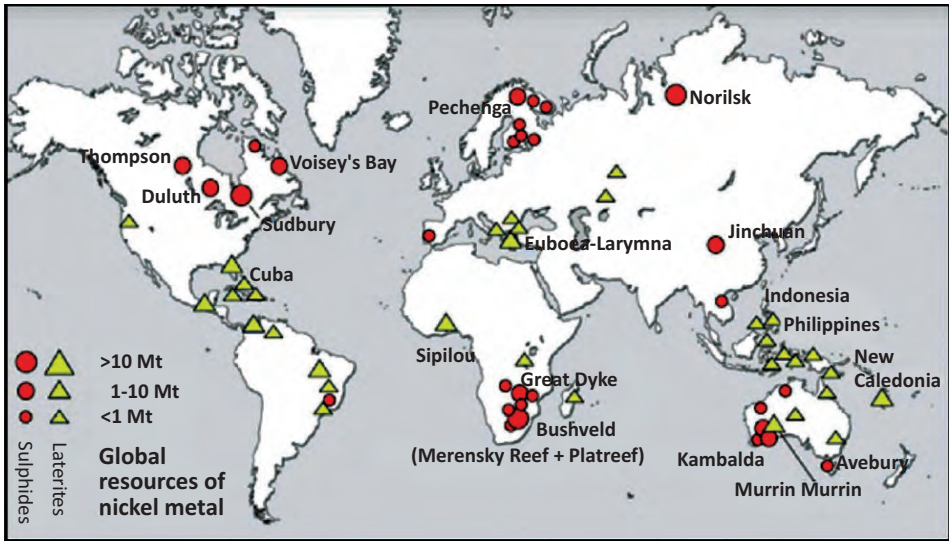


Fig. 3.7: Global Distribution of Nickel

4. **Other applications** - Nickel is used as a catalyst in reforming hydrocarbons, hydrogenation of vegetable oils, production of pesticides, fungicides and fertilizers.

- **Indonesia:** Indonesia is the largest global producer of nickel, particularly through the extraction of nickel laterite ores. The country has large nickel reserves and has become a major player in the nickel industry.
- **Philippines:** The Philippines is another major producer of nickel, with both nickel laterite and nickel sulfide deposits contributing to its output.
- **Russia**: Russia is a significant producer of nickel, with deposits located in the Norilsk-Talnakh region. The ores here are primarily sulfide-type nickel deposits.
- **Canada:** Canada has notable nickel deposits, including those in the Sudbury Basin in Ontario, which is one of the largest and oldest nickel mining areas in the world.
- **Australia**: Australia is a major producer of nickel, with deposits in Western Australia and Queensland. The country has both sulfide and laterite-type nickel deposits.
- **New Caledonia**: This French territory in the Pacific is known for its rich lateritic nickel deposits.

4. Tungsten

- Tungsten, symbolized as **W** on the periodic table, is a dense, hard, and corrosion-resistant metal.
- It is known for its high melting point, exceptional strength, and durability.
- Tungsten has a range of applications in various industries, particularly in manufacturing, electronics, and aerospace, where its properties are highly valued.

Global distribution of Tungsten

- **China:** China is the **largest producer of tungsten in the world,** accounting for a significant portion of global production. The majority of Chinese tungsten deposits are located in the provinces of Jiangxi, Hunan, and Fujian.
- **Vietnam:** Vietnam is another important contributor to the global tungsten supply. The Nui Phao mine is a major tungsten-producing facility in the country.
- **Russia:** Russia has substantial tungsten reserves, and the country is a notable producer. The majority of Russian tungsten comes from the Primorsky and Krasnoyarsk regions.
- **Bolivia:** Bolivia has significant tungsten deposits, and the Chojilla mine is a key tungsten-producing site in the country.
- **Rwanda:** Rwanda has been emerging as a notable tungsten producer, with deposits in the Gatumba area.
- **Portugal:** Portugal is home to the Panasqueira mine, one of the largest tungsten mines in Europe, and it has been a historical tungsten producer.

Applications of Tungsten:

- Tungsten is a valuable metal with widespread use in light-bulb filaments, electron and television tubes, abrasives, and specialized alloys like steel tools.
- Tungsten carbide holds great importance in metalworking, mining, and petroleum industries

5. Antimony

- Antimony is a chemical element with the symbol **Sb** and atomic number **51**. It is a **metalloid**, possessing both metallic and non-metallic properties.
- Antimony and its compounds have applications in various industries like Fire Retardants, alloys, batteries, etc.

Applications of Antimony:

- Antimony alloys serve various purposes in batteries, type metal, low-friction metals, and cable sheathing.
- Antimony compounds contribute to the production of paints, ceramic enamels, flame-retardant materials, glass, and pottery.
- Antimony is a key component in the manufacturing of semiconductors, including infrared detectors and diodes.
- Antimony is utilized to improve the durability and hardness of lead.
- Antimony is an essential ingredient in fire retardants used in numerous commercial and domestic products.

Global distribution of Antimony

- **China**: China is by far the **largest producer of antimony in the world**, accounting for a significant portion of global production. The majority of Chinese antimony deposits are located in the provinces of Hunan, Guangxi, and Yunnan.
- **Russia**: Russia has notable antimony reserves and is one of the top global producers. The country's antimony production comes from various regions, including the Kamchatka Peninsula and the Krasnoyarsk Krai.
- **Tajikistan**: Tajikistan is a significant contributor to global antimony production, with deposits in the Sughd region. The Jijikurt and Konchoch deposits are among the key antimony sites in the country.
- **Bolivia**: Bolivia has substantial antimony resources, and the country has been an important producer. The majority of Bolivian antimony comes from the Mina San Jose deposit.

6. Bauxite and Aluminium

Bauxite

- Bauxite is an ore composed primarily of aluminum hydroxides along with iron, silica, titanium, and other impurities. **It is the primary source of aluminum**.
- Bauxite forms through weathering of aluminum-rich rocks in tropical and subtropical areas. The process involves leaching of soluble minerals, leaving behind a residue rich in aluminum.
- Bauxite varies in color from red to brown, depending on iron content. The major types include **gibbsite, boehmite, and diaspore,** with gibbsite being the most common.

Applications of Bauxite:

1. **Aluminum Extraction:** Bauxite plays a crucial role in various processes such as the Bayer Process and the Hall-Heroult Process, which are integral to extracting aluminum.
2. **Chemical Manufacturing:** Bauxite, in combination with alumina, contributes to the production of aluminum chemicals.

3. **Road Aggregates:** Construction firms utilize calcined bauxite as an anti-skid road aggregate in specific regions to enhance road safety and prevent accidents.
4. **Additional Applications:** While bauxite's usage may be somewhat limited, it finds significant application in industries such as papermaking, water purification, and petroleum refining.

Global distribution of Bauxite

- **Australia:** Australia is the largest producers of bauxite globally, with extensive deposits located in Western Australia, Queensland, and the Northern Territory.
- **China:** China is the second largest producer of bauxite, primarily found in the Guangxi and Henan provinces.
- **Guinea:** Guinea is home to some of the world's richest bauxite deposits, particularly in the Boke region.
- **Brazil:** Brazil has substantial bauxite reserves, with major deposits found in the states of Minas Gerais and Pará.
- **India:** India possesses sizable bauxite resources, concentrated in states like Odisha, Gujarat, and Jharkhand.
- **Indonesia:** Indonesia is a notable bauxite producer, with significant deposits on the islands of Borneo and Sumatra.

Aluminium

- **Aluminium is a lightweight, corrosion-resistant metal with excellent conductivity. It is the third-most abundant element in the Earth's crust.**
- Aluminium is extracted from bauxite through the **Bayer process**. Bauxite is crushed, refined into alumina, and then electrolyzed to produce aluminum metal.
- Aluminium is known for its low density, high strength-to-weight ratio, corrosion resistance, and malleability. It is extensively used in various industries, especially aerospace, construction, and transportation.

Global distribution of Aluminium

- **China:** China is **the world's largest producer of aluminum,** with a substantial portion of its production relying on domestic bauxite sources.
- **Russia:** Russia has a significant aluminum industry, with production mainly sourced from domestic bauxite and alumina.
- **Canada:** Canada is a major producer of aluminum, utilizing bauxite imports and domestic resources, particularly in Quebec.
- **United Arab Emirates:** The UAE, specifically Dubai and Abu Dhabi, has a notable aluminum industry, with a focus on importing bauxite and alumina for processing.
- **Australia:** Australia is a significant contributor to global aluminum production, utilizing its abundant bauxite reserves.
- **India:** India has a growing aluminum industry, relying on both domestic bauxite and imports.

7. Zinc

- Zinc is a bluish-white metal with good corrosion resistance, and it is commonly used in various industrial applications.
- It is a relatively brittle metal with a low melting point.
- It has good corrosion resistance, forming a protective layer of oxide on its surface. It readily reacts with acids.

Global distribution of Zinc

- **China**: China is the **largest producer of zinc globally**, with substantial reserves and a well-established mining industry.
- **Australia**: Australia is another significant contributor to global zinc production, hosting large zinc deposits and operating mines.
- **Peru**: Peru is a major zinc-producing country in South America, with significant reserves and active mining operations.
- **United States:** The U.S. also has notable zinc deposits, and it has historically been a significant producer.
- **India**: India is among the top zinc-producing countries, with substantial reserves and mining activities.
- **Canada**: Canada has significant zinc deposits, and mining operations contribute to global zinc production.
- **Mexico**: Mexico is a key player in the zinc market, with substantial reserves and a well-established mining sector.
- **Kazakhstan**: Kazakhstan contributes to global zinc production with its mining activities and reserves.

Applications of Zinc

- **Galvanization:** A significant portion of zinc is used for galvanizing steel to protect it from corrosion. This involves coating steel with a layer of zinc to form a sacrificial barrier.
- **Alloys:** Zinc is used in various alloys, such as brass (copper-zinc alloy) and zinc-aluminum alloys. These alloys exhibit improved properties for specific applications.
- **Batteries:** Zinc is used in the production of certain types of batteries, including zinc-carbon and alkaline batteries.
- **Chemical Industry:** Zinc compounds find applications in the chemical industry, including the production of zinc oxide, which is used in rubber manufacturing, ceramics, and as a sunscreen ingredient.

8. Lead

- Lead is a heavy metal with the symbol Pb (from the Latin word "plumbum").
- It is a highly malleable and ductile metal known for its density and corrosion resistance.
- Lead has been used by humans for thousands of years, primarily for applications such as plumbing, construction, and, more recently, in batteries.

Applications of Lead:

1. Lead's chemical resistance makes it a popular choice for roofing, covering subterranean or underwater electric wires, and lining water pipes, conduits, and structures used in transporting and processing corrosive substances.
2. Molten lead serves as an effective solvent and collector for elemental silver and gold.

Global distribution of lead

- **China**: China has been the **largest producer and consumer** of lead for many years. It possesses substantial lead reserves, and its mining and refining activities contribute significantly to the global lead supply.
- **Australia**: Australia is another major player in lead production, with substantial lead reserves. The country's mining industry, particularly in regions like Broken Hill, has been a significant source of lead.
- **United States**: The United States also has considerable lead reserves. States like Missouri and Alaska historically have been important contributors to lead production.
- **Peru**: Peru is a significant lead producer in South America, with notable lead reserves. The country's mining industry plays a crucial role in its economy.
- **Russia**: Russia has substantial lead reserves, and its mining activities contribute to both domestic consumption and exports.

9. Tin

- Tin is a soft, malleable, and silvery-white metal with a relatively low melting point.
- It is often alloyed with other metals, primarily forming **tin alloys like bronze and pewter.**
- Tin has good corrosion resistance and is commonly used as a coating for other metals to prevent **corrosion.**

Applications of Tin:

1. Iron is shielded from corrosion through tin-plating, preserving its integrity.
2. Tin piping and valves are essential for maintaining the purity of water and beverages, while molten tin serves as the foundation for float plate-glass production. Although pure tin lacks strength, it is utilized in various alloys for structural applications, such as bronzes, pewter, and bearing metals. Other uses include lead-based solders, bell metal, babbitt metal, and low-temperature casting alloys.
3. Tin oxide, featuring tin in the +4 oxidation state, finds application in rendering ceramic bodies opaque, serving as a mild abrasive, and acting as a weighting agent for fabrics.
4. Tin fluoride and tin pyrophosphate, with tin in the +2 oxidation state, are utilized in dentifrices.
5. Organic tin compounds serve as stabilizers in specific plastics and function as wood preservatives.

Global distribution of Tin

- **China**: China has consistently been the **largest producer of tin,** with significant deposits in provinces such as Yunnan and Guangxi.
- **Indonesia**: Indonesia is another major player in the tin market, particularly with extensive tin mining activities on the islands of Bangka and Belitung.
- **Myanmar**: Myanmar has significant tin reserves and is a notable producer of the metal.
- **Brazil**: Brazil has substantial tin deposits, and the metal is extracted mainly in the states of Amazonas and Rondônia.
- **Peru**: Peru is also a significant tin producer, with mining operations in areas like Puno and San Martín.
- **Bolivia**: Bolivia has historically been a significant producer of tin, with deposits located in areas such as Oruro.

10. Gold

- Gold is a precious metal with unique properties, such as high malleability, conductivity, and resistance to corrosion.
- It has been valued for its beauty and rarity throughout history and is often used in jewelry, investment, and various industrial applications.

Applications of Gold:

1. The electronics industry extensively utilizes gold for crafting corrosion-resistant electrical connectors.
2. Gold alloys find notable applications in restorative dentistry, with gold frequently incorporated into crowns or dental bridges during tooth restoration procedures.
3. Suspensions containing gold nanoparticles, commonly termed colloidal gold, are prevalent in medical research as well as studies in materials science and biology.

Global distribution of Gold

- **Witwatersrand Basin, South Africa:** This region has historically been one of the world's leading gold producers, contributing significantly to global gold production.
- **Carlin Trend, United States:** Located in Nevada, the Carlin Trend is a major gold-producing area in the United States, hosting several large gold mines.
- **Super Pit, Australia:** The Super Pit in Western Australia is one of the world's largest open-pit gold mines, contributing significantly to Australia's gold production.
- **Grasberg Mine, Indonesia:** This mine is one of the world's largest gold and copper producers, located in Papua province. It is a significant contributor to Indonesia's gold output.
- **Yanacocha, Peru:** Yanacocha is one of the largest gold mines in South America, situated in the Andes mountains. Peru is a major gold producer in the region.
- **Muruntau, Uzbekistan:** Muruntau is one of the largest gold mines in the world and is located in Central Asia, contributing to Uzbekistan's gold production.

11. Silver

- Silver is a metallic element with the chemical symbol (Ag) and atomic number 47.
- It is a lustrous, white, and ductile metal with high electrical and thermal conductivity.
- Silver has been valued for its various uses, including as a currency, in jewelry, and in various industrial applications.

Applications of Silver:

1. Some countries still employ silver coins as currency.
2. Silver is commonly utilized in the creation of jewelry and silverware.
3. It finds application in the production of solar panels.
4. Silver is integral to the manufacturing of standard air conditioning systems.

5. Water purifiers often incorporate silver to inhibit the growth of algae and bacteria within filters.
6. It is prevalent in photography and electronic device manufacturing.
7. Silver is employed as an antibiotic coating on medical devices.

Global distribution of silver

- In terms of global distribution, silver is found in nature primarily as a byproduct of the mining of other metals, such as lead, zinc, and copper.
- The largest silver-producing countries include Mexico, Peru, China, Russia, and Chile. These nations contribute significantly to the global supply of silver through mining activities.

12. Platinum

- Platinum is a precious metal with the chemical symbol (Pt) and atomic number 78.
- It belongs to the Platinum Group Metals (PGMs), which also include palladium, rhodium, ruthenium, iridium, and osmium.
- Platinum is known for its lustrous, silvery-white appearance and is highly valued for its rarity, durability, and diverse industrial applications.

Global distribution of platinum

- **South Africa:** South Africa is the leading producer of platinum, accounting for a significant portion of global production. The Bushveld Complex in South Africa is a major geological formation where platinum deposits are found.
- **Russia**: Russia is another major contributor to global platinum production. The Norilsk Nickel mining complex in Russia is a significant source of platinum-group metals, including platinum.
- Top 5 producers of platinum are South Africa > Russia > Zimbabwe > Canada > United States.

13. Lithium

- It is a soft, silvery-white alkali metal and is the **lightest metal and lightest solid element under standard conditions.** It is sometimes also referred as **'white gold'.**
- Lithium is highly reactive and flammable and must be stored in mineral oil.
- It is a key component in the manufacturing of rechargeable batteries, particularly lithium-ion batteries, which are widely used in electronic devices and electric vehicles due to their high energy density.

Global distribution of Lithium

- **Chile** has the **largest lithium reserves** in the world of 9.2 million tons in total.
- **Australia** has the second-largest lithium reserves in the world with 5.7 million tons.
- **Argentina** is third in terms of the size of its lithium reserves with a total of 2.2 million tons.
- **China** ranks fourth in terms of the size of its lithium reserves with a total of 1.5 million tons.

Lithium reserves in India
In February 2023, the **Geological Survey of India (GSI)** established lithium-inferred resources of **5.9 million tonnes** in the **Salal-Haimana area** of the Reasi district in Jammu and Kashmir (J&K). This discovery makes **India** the **seventh-largest source** of lithium globally.

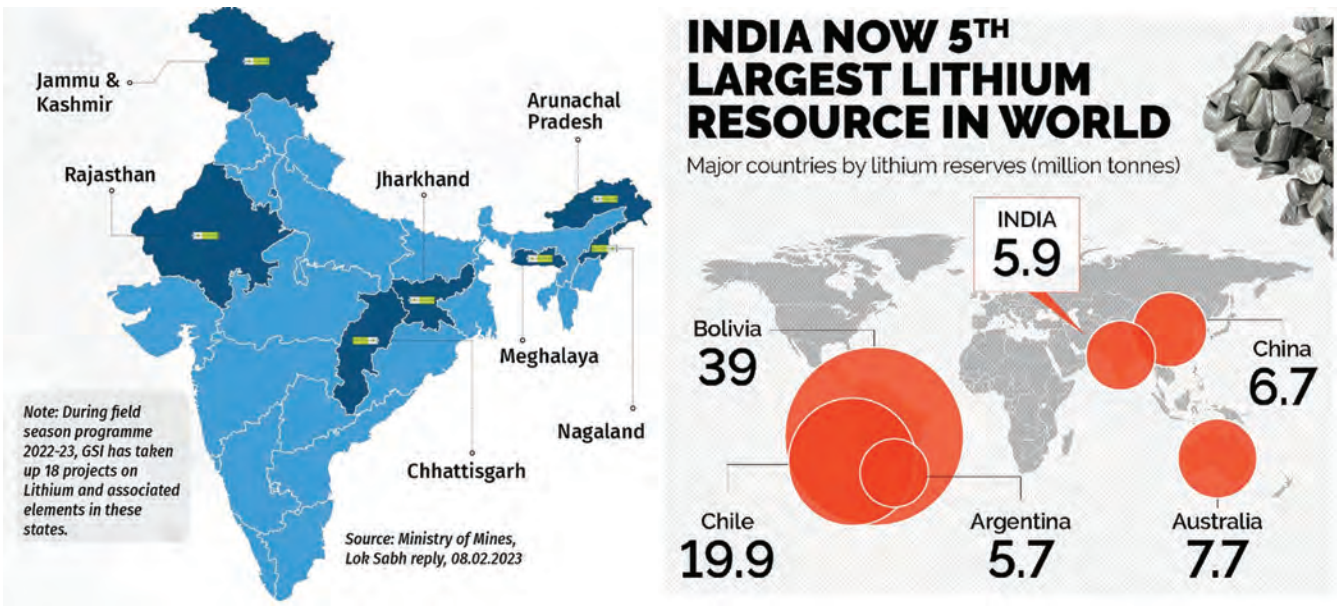


Fig. 3.8: Distribution of Lithium: India & World

Lithium Triangle

The Lithium Triangle refers to a region in South America encompassing parts of **Argentina, Bolivia, and Chile.** This area is known for its significant lithium reserves and is considered one of the world's most important sources of lithium, a key component in rechargeable batteries used in electric vehicles, consumer electronics, and energy storage systems.

- **Argentina:** Argentina is home to lithium reserves primarily located in the Andes mountain range, particularly in the northwestern provinces of Salta, Jujuy, and Catamarca. The Salar del Hombre Muerto and Salar del Rincon are among the largest lithium-rich salt flats in the country.
- **Bolivia:** Bolivia possesses vast lithium reserves concentrated in the Salar de Uyuni, the world's largest salt flat. The lithium deposits in Bolivia are mainly found in the form of lithium-rich brine, making extraction technically challenging but potentially lucrative.
- **Chile:** Chile is a major producer of lithium, with significant reserves located in the Atacama Desert in northern Chile. The Salar de Atacama is one of the world's richest lithium brine deposits. Chile's lithium production is dominated by large multinational companies operating extraction facilities in the region.
- The Lithium Triangle plays a crucial role in global lithium supply, attracting investments from multinational corporations and governments seeking to capitalize on the growing demand for lithium-ion batteries. However, challenges such as environmental concerns, water scarcity, indigenous rights, and political instability pose significant hurdles to the sustainable development of lithium resources in the region.

Fig. 3.9: The Lithium Triangle region

Application of Lithium

- **Batteries:** Lithium-ion batteries are the most well-known application of lithium. These rechargeable batteries are widely used in electronic devices such as smartphones, laptops, tablets, and cameras, as well as in electric vehicles (EVs) and energy storage systems (ESS) for renewable energy sources like solar and wind.
- **Electric Vehicles (EVs):** Lithium-ion batteries are the primary energy storage solution in electric vehicles. Lithium's high energy density, lightweight nature, and ability to recharge efficiently make it ideal for powering electric cars, buses, and trucks, contributing to the transition towards sustainable transportation and reduced reliance on fossil fuels.
- **Consumer Electronics:** Lithium batteries power a wide range of consumer electronics, including portable devices such as cordless power tools, handheld gaming consoles, fitness trackers, and smartwatches. Lithium's high energy density and long-lasting performance make it suitable for powering these devices efficiently.
- **Industrial Applications:** Lithium compounds and chemicals have various industrial applications. Lithium carbonate and lithium hydroxide are used in the production of ceramics, glass, lubricants, greases, and air conditioning systems. Lithium-ion batteries also find applications in industrial equipment, robotics, and unmanned aerial vehicles (drones).
- **Medical Devices:** Lithium batteries are utilized in medical devices such as pacemakers, hearing aids, defibrillators, and infusion pumps. These devices require reliable, long-lasting power sources, and lithium batteries offer the necessary performance and durability for medical applications.
- **Aerospace and Defense:** Lithium batteries are used in aerospace and defense applications for powering satellites, spacecraft, unmanned aerial vehicles (UAVs), and military equipment. Lithium's lightweight and high energy density make it suitable for meeting the power demands of these critical applications.
- **Energy Storage Systems (ESS):** Lithium-ion batteries are increasingly deployed in energy storage systems (ESS) to store electricity generated from renewable sources such as solar and wind. These batteries help balance supply and demand, stabilize grid operations, and support the integration of renewable energy into the power grid.

Non-Metallic Minerals

Non-metallic minerals are those minerals which do not contain a metallic element. They are commonly found in sedimentary rocks and yong fold mountains. They are highly malleable and ductile.

1. Mineral Fuels

Mineral fuels or fossil fuels are fuels which are used for energy use. Major mineral fuels include coal, petroleum and natural gas.

A. Coal

- Coal is a fossil fuel that is formed from the remains of plants that lived and died millions of years ago.
- There are **four** main types of coal, each with different carbon content and energy potential.
  - **Anthracite:** This is the highest rank of coal and has the highest carbon content. Anthracite contains **86%–97% carbon** and generally has the highest heating value of all ranks of coal. It is hard, shiny, and has a high energy content. Anthracite is relatively rare and is often used in industrial processes and residential heating where high heat intensity is required.

- **Bituminous:** This type of coal has a moderate carbon content and is the most widely used in the world. Bituminous coal contains **45%–86% carbon.** It is used primarily for electricity generation and to make coke for steel production. Bituminous coal is known for its relatively high energy content and is found in abundance in many coal-producing regions.
- **Sub-bituminous:** This type of coal has a lower carbon content and higher moisture content compared to anthracite and bituminous coal. Sub-bituminous coal contains **35–45% carbon.** It's commonly used in electricity generation due to its availability and relatively cleaner burning properties compared to lignite.
- **Lignite:** This is the lowest rank of coal with the lowest carbon content. Lignite contains **25%–35% carbon** and has the lowest energy content of all coal ranks. It has a high moisture content and is less energy-dense compared to other types. Lignite is used primarily for electricity generation, particularly in power plants that are located near the mines due to its relatively low energy density and high moisture content, making transportation less economical.

Significance of coal in contemporary world

- **Electricity Generation:** Coal remains a significant source of electricity in many parts of the world, especially in developing countries. Despite growing interest in renewable energy, coal-fired power plants continue to play a crucial role in meeting global energy demands.
- **Steel Production:** Metallurgical coal (coking coal), a subtype of bituminous coal, is essential for the production of coke, a key component in steelmaking. The steel industry is a major consumer of coal.
- **Industrial Processes:** Coal is used in various industrial processes, including cement production and chemical manufacturing.
- **Environmental Concerns:** The significance of coal also comes with environmental challenges, primarily due to carbon dioxide emissions and other pollutants associated with its combustion. Efforts to address climate change are driving a shift towards cleaner and more sustainable energy sources.

Distribution of Coal

Coal Reserves

- More than 90% of the world's total proved coal reserves are located in just ten countries. The US tops the list holding more than one-fifth of the total proven coal reserves, while China, which ranks third, is the biggest producer and consumer of coal.
- Top five countries and their percentage share of world proved coal reserves as of 2021: United States (22%), Russia (15%), Australia (14%), China (14%), India (11%).

--British Colombia
--Alberta & Saskatchewan
-Pittsburg Coal Seam.
-Appalachian Mountain Region
-High Quality Carboneferous Coal
South Whales & Yorkshire
Rhineland Region
Ruhr
Pechora Baisn
Ural Region
Moscow Basin
Lena Basin
Tungus Basin
Kuzbas or Kuznetsk Basin
Kempine
Donbass Basin
Inner Mongolia
Fushan
Shanxi
Wooming
Utah Region
Asturias and Leon
Russia is trying to occupy this region of Ukraine. The region is rich in iron ore and coal
Xinjiang
Raniganj
Jahria
Bokaro
Pench
Kannah
Guizhou
Singareni
--The Great Lakes Region if highly industrialised due to rich coal and iron reserves in close proximity.
--St Lawrence waterway provides easy transportation for the export of finished goods
Cerrejon Coal Mine
Colombia
Enugu
Scattered along East African Rift Valley
--India has huge coal reserves but still it imports coal from Australia and Insonesia
--Coking coal is very scarce. Most of the coking coal is imported from Australia, Indonesia
Most of the China's Coal is of poor quality. Metallurgical coal or coking coal is imported from Australia, Indonesia, South Africa
Santa Catarina
Rio Grande do Sul
have significant reserves
Transvaal
Natal
Perth
Collie
Concepcion
--Only South Africa has significant coal reserves in Africa.
--Most of the coal is exported to China
Major Coal mines scattered along Eastern Australia [To the west of Australian Alps]

Fig. 3.10: Global Distribution of Coal

Countries Resized Relative to Coal Reserves	
World Total	**826.0 billion**
United States	238.3 billion
Russia	157.0 billion
China	114.5 billion
Australia	76.2 billion
India	58.6 billion
Ukraine	33.9 billion
Kazakhstan	31.3 billion
South Africa	30.4 billion

Fig. 3.11: Global Coal Reserves Data

Production and Consumption

- Globally, China is the largest producer of coal by a considerable margin. In 2022, China accounted for over **52 percent** of the coal production worldwide. In comparison, **the second largest coal producer, India**, had a global share of nearly **nine percent.**
- **"Top 5 Coal Producers (2022):** China (5.6 billion tonnes - 50%), India (777.2 million tonnes - 13%), United States (483.3 million short tons - 8%), Australia (426.4 million tonnes - 7%), Indonesia (563.4 million tonnes - 10%).

- **Top 5 Coal Consumers (2022):** China (5.3 billion tonnes - 53%), India (1.1 billion tonnes - 11%), United States (533.3 million short tons - 5%), Japan (173.4 million tonnes - 2%), South Korea (133.2 million tonnes - 1%)."

B. Petroleum

Petroleum, or crude oil, is found in underground rock formations called reservoirs. These reservoirs are typically located in sedimentary basins, and the distribution of petroleum deposits is influenced by geological and tectonic processes.

Sources

- **Sedimentary Basins:** Most petroleum reservoirs are found in sedimentary basins, which are large depressions in the Earth's crust filled with layers of sedimentary rocks. These basins can be onshore or offshore.
  - **Example**: **The Gulf of Mexico** is a prime location with numerous sedimentary basins that host significant oil reservoirs. It is a major offshore oil-producing region, with countries like the United States and Mexico having substantial oil exploration and production activities in this basin.
- **Continental Shelves:** Offshore continental shelves, where the ocean floor extends gradually away from the continents, are often rich in oil deposits. Many significant offshore oil fields are located on continental shelves.
  - **Example: The North Sea,** located between the United Kingdom and continental Europe, is known for its extensive continental shelves with rich oil and gas deposits. Countries like Norway, the United Kingdom, and Denmark have developed substantial offshore oil and gas industries in this region.
- **Desert Regions:** Some petroleum reservoirs are found in desert regions where ancient seas once existed, leaving behind sedimentary rock formations that can contain oil deposits.
  - **Example: The Ghawar Field in Saudi Arabia**, one of the largest and most productive oil fields globally, is situated in a desert region. The Arabian Peninsula, with its arid landscapes, has proven to be a significant source of petroleum resources.
- **Tectonic Plate Boundaries:** Oil reservoirs can be associated with tectonic plate boundaries, where the Earth's crust is subject to significant geological activity. Folded and faulted rock structures in these areas can trap and accumulate oil.
  - **Example: The Permian Basin in the United States,** located in Texas and New Mexico, is associated with tectonic activity and is one of the most prolific oil-producing regions globally. It has a history of oil extraction from both conventional and unconventional reservoirs.
- **Source Rocks:** Petroleum is often generated and expelled from source rocks, which are organic-rich sediments. These source rocks are usually shale or limestone that have undergone heat and pressure over geological time.
  - **Example: The Bakken Formation**, spanning parts of the United States and Canada, is a source rock for oil. Advances in hydraulic fracturing (fracking) technology have allowed for the extraction of oil from shale formations, contributing to the region's oil production.
- **Anticlines and Fault Traps:** Structural features like anticlines (upfolded rock layers) and fault traps can create reservoirs for oil. Oil accumulates in these traps due to the impermeable nature of certain rocks, preventing the upward movement of oil.
  - **Example: The Campos Basin** off the coast of Brazil is characterized by various structural features, including anticlines and fault traps. It is a significant offshore oil-producing area, and Brazil has developed major oil fields in this basin, such as the giant Tupi and Lula fields.
- **Oil Sands:** In some regions, particularly in Canada and Venezuela, significant petroleum resources are found in the form of oil sands or tar sands. These are unconventional deposits where bitumen, a heavy form of crude oil, is mixed with sand and clay.
  - **Example: The Athabasca Oil Sands in Alberta, Canada**, is one of the largest reserves of oil sands in the world. The region contains vast deposits of bitumen mixed with sand and clay. Extraction methods, such as mining and in-situ techniques, are used to recover bitumen from the oil sands.

Sr. no.	Country ↑↓	Oil Reserves(barrels) in 2016 ↑↓	World Share ↑↓
1	Venezuela	299,953,000,000	18.2%
2	Saudi Arabia	266,578,000,000	16.2%
3	Canada	170,863,000,000	10.4%
4	Iran	157,530,000,000	9.5%
5	Iraq	143,069,000,000	8.7%

Fig. 3.12: Top 5 oil reserves in the world

Distribution of petroleum

The distribution of mineral oil across the world is uneven, resulting in significant strategic implications due to its lopsided availability across different regions.

- **Venezuela** holds the largest oil reserves globally, with nearly 303 billion barrels mainly located in the Orinoco Belt at the southern end of the eastern Orinoco River Basin.
- Other major countries with significant oil reserves include Saudi Arabia,Canada,Iran,Iraq and Kuwait.

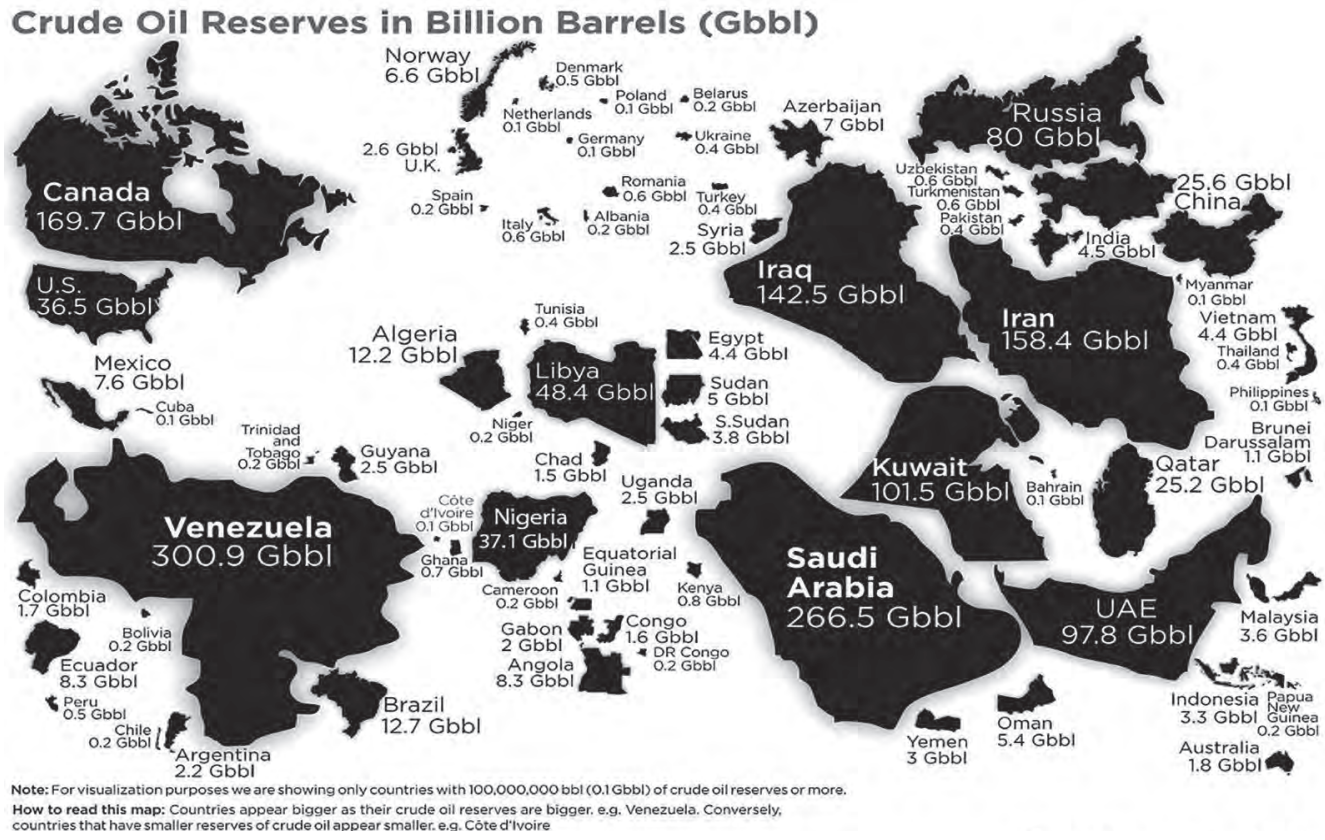


Fig. 3.13: Global distribution of crude oil reserves in the world

Top producers

Country	Million barrels per day	Share of world total
United States	20.30	21%
Saudi Arabia	12.44	13%
Russia	10.13	10%
Canada	5.83	6%
Iraq	4.61	5%

Fig. 3.14: World's Top 5 Oil Producers & their Share in World Production

Top consumers

Country	Million barrels per day	Share of world total
United States	19.89	20%
China	15.27	16%
India	4.68	5%
Russia	3.67	4%
Japan	3.41	4%

Fig. 3.15: World's Top 5 Oil Consumers & their Share in World Production

2. Mica

- Mica is a mineral that is widely distributed around the world and can be found in various geological settings.
- It is a group of **sheet silicate minerals,** characterized by their excellent basal cleavage, which allows them to be split into thin, flexible sheets.
- The two most common types of mica are **muscovite and biotite.**
- Mica is often associated with rocks like **granite, schist, and gneiss.**
- It is commonly mined for various industrial applications due to its unique properties, including its **electrical insulating and heat-resistant qualities.**

Applications of Mica:

1. Mica Powder Uses – Mica powder is employed in decorations, clay pots, traditional pottery, colored powders, and printing techniques.
2. Mica Sheets Applications – Mica sheets are used as window panes, in toys, electronics, microscopy, oxygen-breathing equipment, compasses, thermal regulation, optical fibers, pyrometers, and heaters.
3. Mica in Daily Life - Mica is ubiquitous, used in construction, cosmetics, and as a pigment extender due to its platy texture and versatility.

Distribution of mica

- **India:** India is one of the largest producers of mica in the world. The states of Jharkhand, Bihar, Rajasthan, and Andhra Pradesh are particularly known for their mica deposits.
- **China:** China is another major producer of mica, with significant deposits in various provinces, including Guangdong, Jiangxi, and Yunnan.
- **Russia:** Russia has mica deposits in areas such as the Ural Mountains.

- **United States:** Mica can be found in several U.S. states, including North Carolina, Virginia, Georgia, and South Dakota.
- **Brazil:** Mica deposits are also present in Brazil, with some significant occurrences in Minas Gerais.
- **Canada:** In Canada, mica deposits are found in regions like Ontario and Quebec.
- **Madagascar:** The island of Madagascar is known for its mica deposits.

Production and Consumption

- The **largest mica producer in the world** in 2022 was **China**, producing an estimated **100,000 metric tons** of mica.
- Following China was **Madagascar**, which produced **65,000 metric tons** that year.
- **India's** production of mica was estimated to be **16,000 metric tons** in 2022.

3. Potash

- Potash, which primarily refers to various potassium salts, is found in locations around the world, often in the form of **evaporite deposits.**
  {Evaporite deposits are formed when water containing dissolved minerals evaporates, leaving behind the solid mineral deposits}
- Potash is a key component in fertilizers, playing a crucial role in supporting global agriculture.
  - **Global distribution of potash:** Canada, Russia, Belarus, China, United States.
  - **Top producers of potash (2022):** Canada > China > Russia > Belarus > Germany
  - **Top consumers of potash (2022):** China > Brazil > United States

4. Phosphate

- Phosphate deposits are found in various parts of the world and are an important resource for the production of fertilizers, as well as for other industrial applications.
- The largest phosphate deposits are generally located in **sedimentary rock formations.**
- The primary market for phosphate rock is the production of phosphate fertilizer products such as **ammonium phosphates and superphosphates.**
- Phosphorus is essential for the development of roots in plants and assists in producing higher yields.

Application of Phosphates

- **Fertilizers:** Essential for plant growth, boosting food production.
- **Food Additives:** Enhance texture, flavor, and shelf life of processed foods.
- **Detergents:** Key ingredient in cleaning products, removing dirt and grime.
- **Flame Retardants:** Enhance fire safety in various materials.
- **Medicine:** Used in specific medications and treatments.

Global distribution of Phosphate

- **Morocco:** Most of the world's phosphate reserves are in **Morocco**, with the country accounting for approximately **70% of the total reserves** or 50 billion tons.
  - Morocco remains the **largest exporter of phosphate.**
- **China** accounts for 5% of the total reserves, translating to approximately 3.1 billion tons.
  - If China maintains the current production rate, its phosphate reserve will be exhausted in the next 35 years.
- **Syria and Algeria** have the third largest phosphate reserves in the world.
  - Both countries account for 3% of the world's phosphate reserves each, translating to approximately 1.8 and 2.2 billion metric tons respectively.
- **Russia, South Africa, the US, Egypt, and Jordan** each account for 2% of the world's phosphate reserves.
  - The largest supplier of phosphate raw material in Russia is the OJSC Apatit.
  - South Africa is the second-largest producer of phosphate in Africa, boasting of about 1.5 billion tons.
  - There are about 10 active phosphate mines in the US spread across the states of Florida, Idaho, North Carolina, and Utah totaling about 1.1 billion metric tons.
- **Peru, Saudi Arabia, Senegal, Australia, and Iraq** each account for 1% of the phosphate reserves in the world.

Production and consumption

- **Top producers:** China > Morocco > USA
- **Top consumers:** China > Africa > USA

5. Sulphur

Sulphur occurs in various forms, including elemental sulfur and sulfide minerals. The specific geological conditions and processes determine the type and abundance of sulfur deposits in a particular region. Additionally, sulfur is an essential element in biological processes and is part of the sulfur cycle, where it moves through the atmosphere, hydrosphere, and lithosphere.

Global distribution of Sulphur

- **Volcanic Regions:** Sulfur is often associated with volcanic activity. Volcanic regions, such as those along tectonic plate boundaries, can have sulfur deposits. Volcanic gases may contain sulfur compounds, and as these gases cool, sulfur minerals can form.
- **Salt Domes:** Sulfur deposits are sometimes found in association with salt domes. Salt domes are underground formations of salt that can trap and contain sulfur deposits.
- **Hydrothermal Vents:** Some sulfur minerals can be found around hydrothermal vents on the ocean floor. These vents release hot, mineral-rich fluids into the ocean, and sulfur minerals may precipitate out of these fluids.
- **Evaporite Deposits:** Sulfur can be found in certain evaporite deposits, where minerals precipitate as water

evaporates. Examples include gypsum and anhydrite, which may contain sulfur.

- **Sedimentary Rocks:** Sulfur may also be present in certain sedimentary rocks. Organic matter in sediments can break down to release sulfur compounds, which may then become part of the rock formation.
- **Associated with Oil and Gas Deposits:** Sulfur can be found in association with oil and gas deposits. It may be present as hydrogen sulfide gas or in sulfur-rich minerals.

MINERALS IN INDIA

- Minerals are valuable natural resources being finite and non-renewable. They constitute the vital raw materials for many basic industries and are a major resource for development. The history of mineral extraction in India dates back to the days of the Harappan civilization. The wide availability of minerals in the form of abundant rich reserves made it very conducive for the growth and development of the mining sector in India.
- The country is endowed with huge resources of many metallic and non-metallic minerals. The mining sector is an important segment of the Indian economy. Since independence, there has been a pronounced growth in the mineral production both in terms of quantity and value. **India produces as many as 95 minerals, which include which includes 4 fuel, 10 metallic, 23 non-metallic, 3 atomic and 55 minor minerals (including building and other materials)**.

Distribution of Mineral Resources in Different Regions of India

The distribution of mineral resources in India exhibits significant variations, often linked to specific geological structures.

- The **Gondwana system**, for instance, is primarily characterized by extensive coal deposits. In contrast, the **Dharwar and Cuddapah systems** are rich in major metallic minerals such as copper, lead, and zinc.
- The **Vindhyan system**, on the other hand, predominantly contains non-metallic minerals like limestone, dolomite, gypsum, and calcium sulfate. When it comes to metallic minerals, the majority are found within the old crystalline rocks of the peninsular plateau region.

Trends in Regional Distribution of Minerals in India

Examining regional trends in mineral distribution across India reveals some distinct patterns.

- Most of the major mineral resources are concentrated east of an **imaginary line connecting Mangaluru and Kanpur**.
- Over 97% of India's coal reserves are located in the valleys of the Damodar, Sone, Mahanadi, and Godavari rivers.
- In contrast, petroleum reserves are predominantly situated in the sedimentary basins of Assam, Gujarat, and the offshore region known as Mumbai High in the Arabian Sea. Recent discoveries have also identified new reserves in the Krishna-Godavari and Kaveri basins.

Major Mineral Belts of India

India's major mineral resources are predominantly concentrated in following distinct belts across the country.

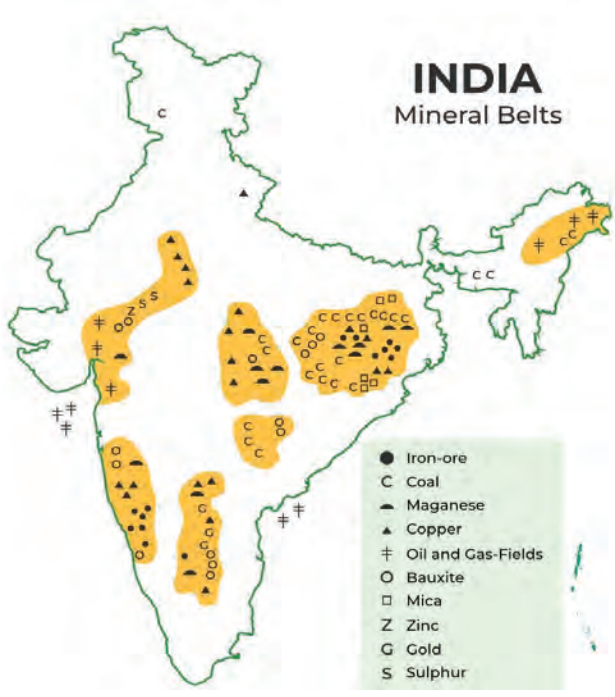


Fig. 3.16: Major Mineral Belts of India

1. **North Eastern Belt:** Encompassing the Chota Nagpur plateau, Orissa plateau, and the eastern Andhra plateau, this region is abundant in a diverse range of minerals essential for metallurgical industries.
   - Notable minerals include iron ore, manganese, mica, bauxite, limestone, and dolomite. Along the river valleys of Damodar, Mahanadi, and Son, rich coal deposits can be found.
   - The region also boasts significant reserves of copper, uranium, thorium, and phosphate.
2. **South-Western Belt:** Spanning the Karnataka plateau and the adjacent Tamil Nadu plateau, this area is particularly rich in metallic minerals like iron ore, manganese, and bauxite, as well as certain non-metallic minerals.
   - Notably, all three of India's gold mines are situated in this region. However, coal is absent from this plateau except for Neyveli lignite.
   - Kerala possesses deposits of monazite, thorium, and bauxite clay, while Goa is renowned for its iron ore deposits.
   - Western Karnataka and Goa are, renowned for its richness in iron ore, garnet, and clay deposits.

3. **North-Western Belt:** Extending from the Gulf of Khambhat in Gujarat to the Aravalli range in Rajasthan, this belt is notable for its copper and zinc deposits.
   - Rajasthan, within this region, is rich in building materials such as sandstone granite, and marble. Extensive deposits of gypsum and Fuller's earth are also present. Dolomite and limestone, abundant in this area, serve as vital raw materials for the cement industry.
   - Petroleum and natural gas constitute principal resources in this belt, while other minerals are found in smaller, scattered quantities
4. **Central Belt:** This region, encompassing Chhattisgarh, Madhya Pradesh, Telangana, Andhra Pradesh, and Maharashtra, boasts abundant reserves of manganese, bauxite, limestone, marble, coal, gems, mica, iron ore, and graphite.

SHARE OF DIFFERENT STATES IN MINERAL PRODUCTION

- Most of mineral producing area are located in peninsular plateau region.
- The north eastern part of peninsular plateau which mainly comprises of Odisha, Jharkhand, and Chhattisgarh is densely rich in natural mineral resources.
- **Odisha accounted for nearly half of India's mineral production, at over 44 percent.**
- Chhattisgarh was the second-largest mining state in India, having accounted for 17.34 percent of the total value of mineral production in India.
- Almost entire production of **calcite, natural gypsum and silver** in the country comes from Rajasthan. The State is a major producer of ball clay, calcite, clay, copper ore/ conc., feldspar, fireclay, limestone, ochre, phosphorite/ rock phosphate and steatite.

Do You Know?

- **Geological Survey of India (GSI):** GSI is the primary source of fundamental earth science data in India, covering all minerals except Uranium (handled by AMD). It stands as the largest and most comprehensive provider of such data.
- **Indian Bureau of Mines (IBM), 1948:** IBM operates under the Ministry of Mines and is responsible for the systematic utilization and conservation of mineral resources, excluding coal, petroleum, natural gas, atomic minerals, and minor minerals. Additionally, IBM enforces regulatory functions as mandated by the Mines and Minerals (Development and Regulation) Act of 1957.
- **National Aluminium Company Limited (NALCO):** NALCO, a Navratna company under the Ministry of Mines, operates a refinery situated in Damanjodi, Koraput district, Odisha.

Metallic Minerals

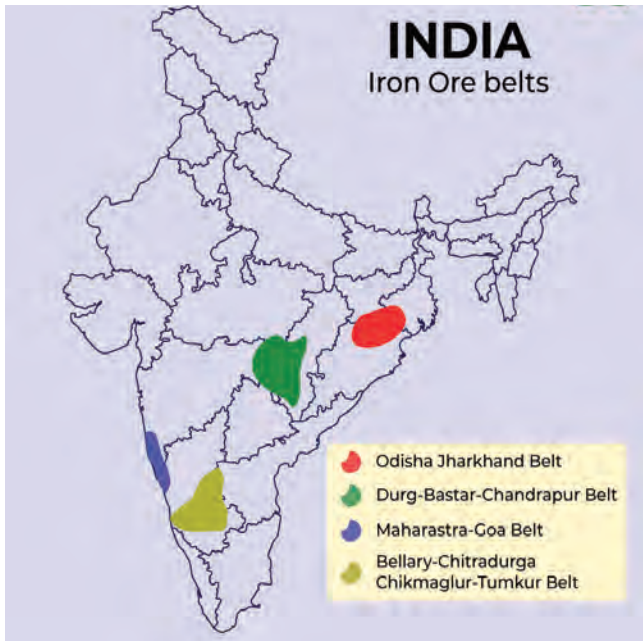


Fig. 3.17: Iron ore Belts of India

India boasts a rich and diverse array of metallic minerals, which play a pivotal role in the nation's industrial and economic landscape. From essential resources like iron and copper to strategically significant elements like nickel and molybdenum, these metallic minerals form the foundation of various industries, ensuring both growth and development.

Iron

- India is endowed with fairly abundant resources of iron ore. The primary iron ore deposits are situated in the states of Odisha, Jharkhand, Chhattisgarh, Karnataka, and Goa.
- Among these, Odisha contributes to approximately 50% of India's total iron ore production.
- The **two most significant iron ore varieties** found in India are **hematite and magnetite**. **Hematite** is especially prized due to its high-grade quality, which is in high demand by numerous steel and iron industries in the country.
- Over the past six decades, most of the larger iron ore belts known for their high-grade ores have been extensively mined. Nevertheless, India possesses substantial resources of low-grade iron ore, but efforts to exploit these have been insufficient.
- **Hematite Reserves:** Presently, nearly all of the iron and its derivative products are sourced from hematite reserves.
  - Approximately 96% of hematite resources are concentrated in the states of Odisha, Jharkhand, Chhattisgarh, Karnataka, and Goa. In Jharkhand, Orissa, and neighboring regions in eastern India, hematite is often found alongside limonite.
  - In the Bellary-Hospet region of Karnataka, hematite ore is discovered along with minor quantities of magnetite.

- Notable hematite deposits are located in Singhbhum district (Jharkhand), Keonjhar (Odisha), Bellary (Karnataka), Bastar district (Chhattisgarh), and Goa.

❑ **Magnetite Reserves:**

- Magnetite reserves, on the other hand, remain largely untapped due to their presence in environmentally fragile areas of the Western Ghats.
- These reserves will remain unexplored until environmentally sustainable mining technologies are developed.
- The primary magnetite ore deposits are primarily situated in the Chikmagalur district (specifically Kudremukh in the Bababudan hills) in Karnataka, as well as the Salem and North Arcot districts in Tamil Nadu.

Iron Ore Production in India

❑ The iron ore production in India increased by ~14% to an all-time high of **282 million tonnes (mnt) in 2023** as against 248 mnt seen in 2022.

❑ **Odisha** produces the lion's share of **56% of India's iron ore** and saw an 18% increase to 159 mnt in 2023 as against 135 mnt recorded in 2022.

❑ **Chhattisgarh** produces 16% of India's iron ore and saw a rise of 8% to 45 mnt in 2023 from 41 mnt in 2022.

❑ **Karnataka** produces 14% of India's iron ore with 39 mnt in 2023. This was an 8% increase from 36 mnt in 2022.

❑ **Jharkhand**, ranked fourth, saw production decline 6% to 22.50 mnt (24 mnt) in this period.

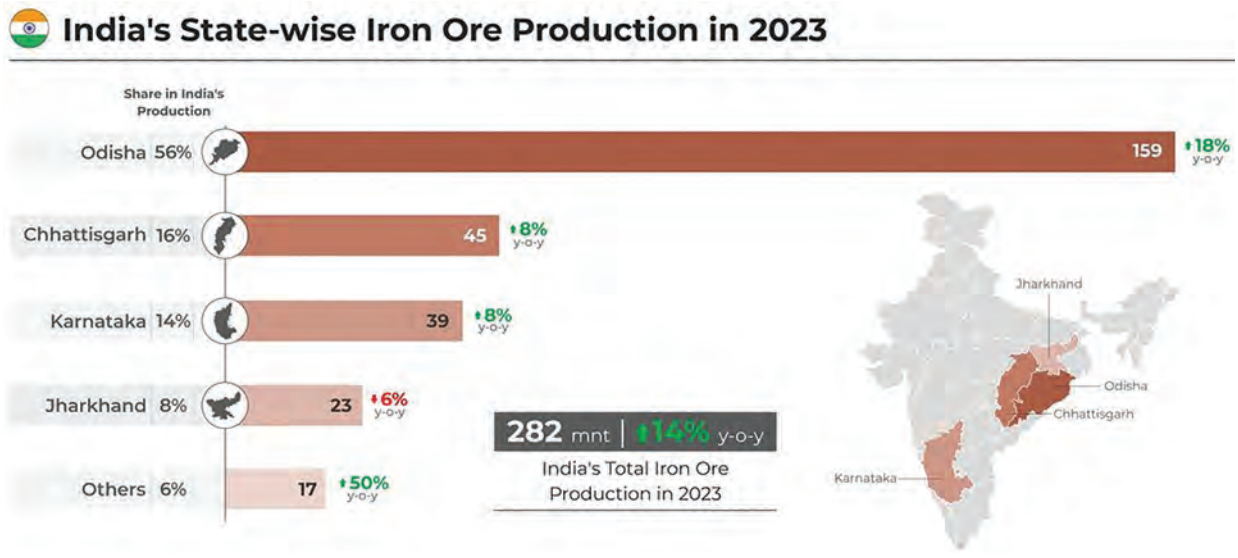


Fig. 3.18: State-wise Iron ore Production (2023)

Imports

❑ India has been a notable importer of iron ore, primarily to meet the demands of its growing steel industry.

❑ As of 2022, India imported the largest quantity of iron ore from **South Africa**, closely followed by **Australia**.

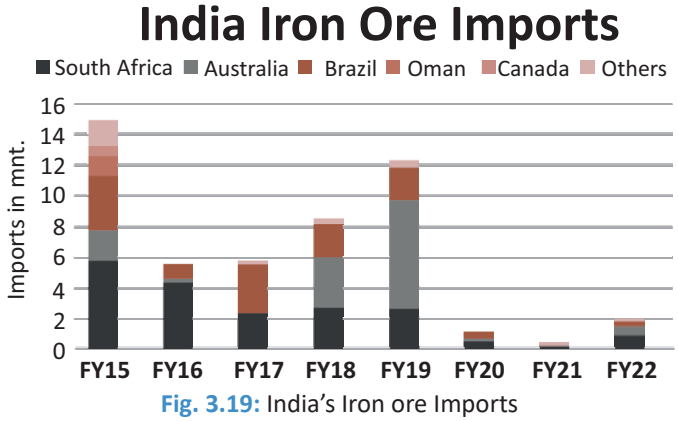


Fig. 3.19: India's Iron ore Imports

Reasons for high import of iron ore in India

{India is one of the largest importers of iron ore globally, despite being a significant producer of the mineral}

❑ **Quality and Grade:** The iron ore produced domestically may not always meet the quality and grade requirements of Indian steel manufacturers. High-quality iron ore is often imported to ensure the production of steel with the desired specifications.

❑ **Domestic Demand:** India has a growing demand for steel due to rapid urbanization, infrastructure development, and industrial expansion. The domestic production of iron ore may not be sufficient to meet the increasing demand from the steel industry.

❑ **Logistical Challenges:** Iron ore deposits are not evenly distributed across India, and transportation infrastructure can be a bottleneck. In some cases, it might be more cost-effective for steel producers to import iron ore from countries with well-established mining and transportation infrastructure.

❑ **Mining Restrictions and Environmental Concerns:** Stringent environmental regulations and mining restrictions in certain states of India have led to fluctuations in domestic iron ore production. This has prompted steel producers to rely on imports to maintain a steady supply.

- **Global Price Dynamics:** The international market for iron ore can sometimes offer competitive prices, influencing Indian steel manufacturers to import iron ore instead of relying solely on domestic sources.
- **Beneficiation and Pelletization Requirements:** The steel industry in India often requires iron ore in a processed and concentrated form. In cases where domestic iron ore needs beneficiation or pelletization before being used in steel production, importing already processed ore can be more cost-effective.
- **Inefficiencies in Domestic Mining Operations:** Some inefficiencies in domestic mining operations, including issues related to technology, productivity, and infrastructure, can impact the competitiveness of Indian iron ore in the global market.

Exports

- **China is the largest export destination of iron ore from India** with a significant share of 81.6%.
- Other major export destinations include South Korea,Indonesia,Oman,Japan,Malaysia and Bahrain.
- In FY2023, the export value of iron ore from India stood at 144.27 billion rupees.

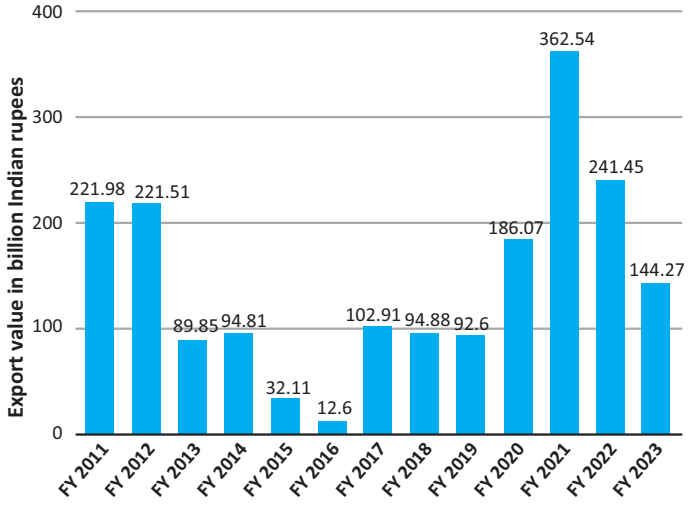


Fig. 3.20: India's iron ore export value

Major problems of iron ore industry in India

- **Illegal Mining:** One of the significant challenges faced by the Indian iron ore industry is illegal mining, leading to environmental degradation, loss of revenue, and social issues. Unregulated extraction has been a concern, and efforts to curb illegal activities have been ongoing.
- **Environmental Impact:** Iron ore mining can have substantial environmental consequences, including deforestation, habitat disruption, and water pollution. Balancing economic development with environmental sustainability has been a constant challenge for the industry.
- **Export Restrictions:** India has imposed various restrictions on the export of iron ore to ensure sufficient supply for domestic industries. These policies aim to support the local steel manufacturing sector and meet the country's infrastructure needs.

Major policies related to the iron ore industry in India

- **Mining Regulations:** The government has implemented and revised mining regulations to govern the extraction and utilization of iron ore resources.
  - These regulations aim to promote sustainable mining practices, prevent illegal mining, and ensure the proper utilization of natural resources.
  - **Example:** The introduction of online auctions for mining leases and efforts to bring transparency into the allocation process were part of the regulatory changes.
- **Export and Import Policies:** The government has periodically adjusted export and import policies to balance domestic demand and supply.
  - Restrictions on iron ore exports have been imposed to ensure an adequate supply for domestic steel production.
  - The government has also imposed **export duty of 50% on all grades of Iron ore** and **45% on Iron ore pellets.**
- **Environmental Regulations:** The government has implemented and strengthened environmental regulations to address the environmental impact of iron ore mining.
  - Companies are required to adhere to strict environmental standards, obtain necessary clearances, and implement measures for environmental conservation.
- **Infrastructure Development:** The government has focused on infrastructure development to facilitate the transportation of iron ore from mining areas to processing plants and ports.
  - Improving transportation infrastructure helps streamline the supply chain and supports the growth of the industry.

Bauxite

Bauxite is the primary source of aluminum, and it is formed through a geological process in wet tropical or subtropical climates where laterite soils are severely leached of soluble materials. This ore undergoes chemical processing to extract aluminum oxide, which is then further refined through smelting using electrolysis to produce aluminum metal.

Distribution of Bauxite in India

The distribution of bauxite in India is a crucial aspect of the country's mineral wealth, as bauxite serves as the primary source of aluminium, a metal of significant importance in various industrial sectors. Understanding the geographical distribution of bauxite deposits in India is essential for appreciating the nation's role in the global aluminium industry and its potential for economic development.

- **Odisha** stands as the largest bauxite-producing state, boasting major mines in Koraput, Kalahandi, and Rayagada districts, with additional deposits extending into Andhra Pradesh.
- **Chhattisgarh** follows as the second-largest producer, with rich bauxite deposits in regions like the Maikala range in Bilaspur, Durg districts, and the Amarkantak plateau areas of Surguja, Raigarh, and Bilaspur.

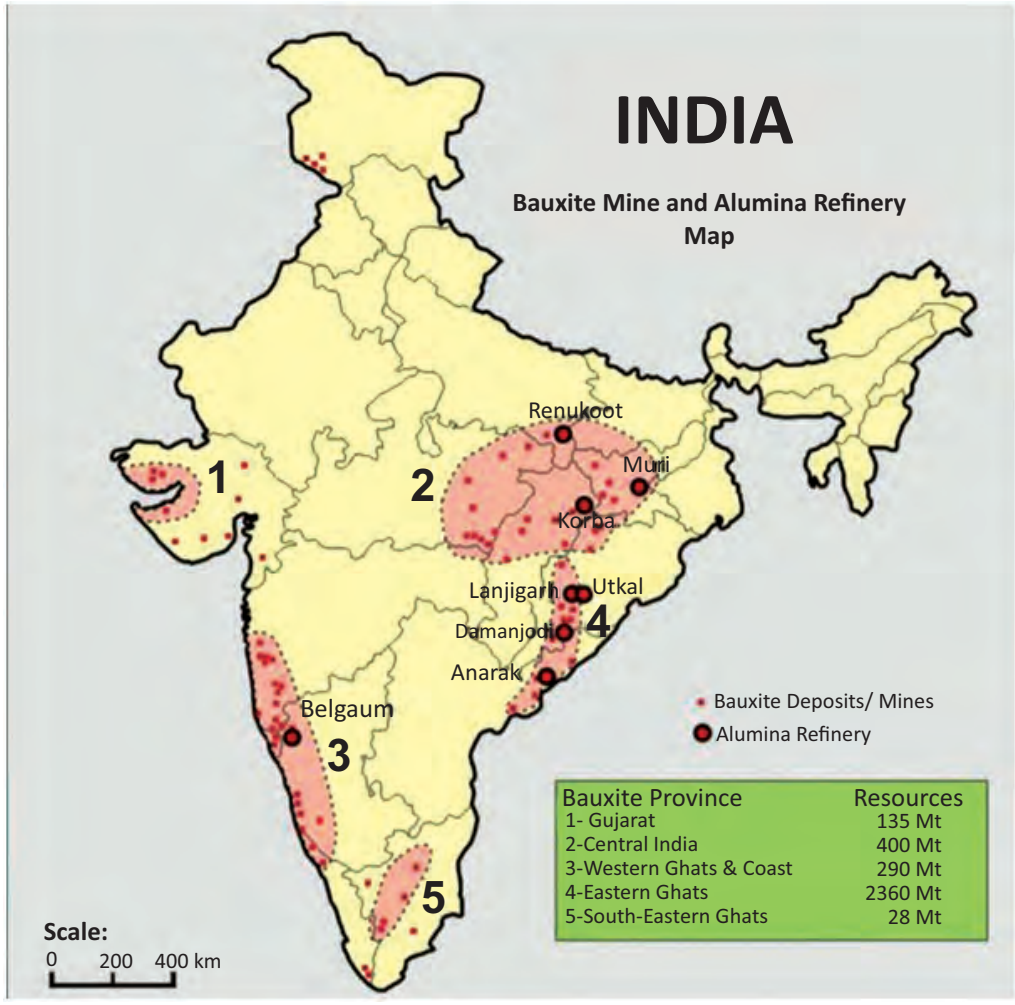


Fig. 3.21: Map of Distribution of Bauxite in India

- **Maharashtra** takes the third position in bauxite production, with its largest deposits concentrated in the Kolhapur district, featuring alumina content ranging from 52 to 89 percent. Other districts in Maharashtra, such as Ratnagiri, Thane, Satara, and Pune, also contribute to the production.
- In **Jharkhand,** bauxite reserves can be found in Ranchi, Lohardaga, Palamu, and Gumla districts, with high-grade ore particularly prevalent in Lohardaga.
- **Gujarat** plays a significant role in India's bauxite production, with crucial deposits located between the Gulf of Kachchh and the Arabian Sea, spanning districts like Jamnagar, Bhavnagar, Junagadh, and Amreli.
- **Madhya Pradesh** contributes from areas such as the Amarkantak plateau, the Maikal range in Shandol, Mandla, and Balaghat districts, as well as the Kotni area of Jabalpur district.
- **Tamil Nadu** has notable bauxite production in the Nilgiri and Salem districts. This diverse distribution of bauxite resources across India helps meet the growing demand for aluminium in various industries.

Imports

- India imports most of its raw bauxite from **Guyana, Pakistan and China** and is the **2nd largest importer of raw bauxite in the World.**

Exports

- India exports most of its Bauxite to **Nepal, Slovenia and France** and is the **2nd largest exporter of Bauxite in the World.**

Lead and Zinc

Lead

- Lead is a unique metal known for its corrosion resistance, ductility, and malleability, making it easily drawn into thin wires and shaped without breaking.

- This blue-grey metal has a relatively low melting point and is denser than most common metals.
- Lead is typically extracted from its principal ore, galena, which often contains silver. This ore is commonly found in veins within limestones, calcareous slates, and sandstones.
- Due to its resistance to corrosive atmospheric gases and acidic substances, lead is extensively utilized for coating iron sheets and lining acid tanks.
- The largest global application of lead today is in the production of lead-acid storage batteries.
- Moreover, lead finds its way into various industries, such as paints, ammunition, and as an alloy with other metals for the production of materials like brass and bronze. Additionally, it serves as a plumbing material in automobiles, airplanes, and electric wires.

Distribution of Lead and Zinc ores in India

- India possesses significant lead and zinc ore reserves, with approximately **2.5 million metric tons** of lead and **10 million metric tons** of zinc.
- These ores are typically found in conjunction with other metals like silver and cadmium. Interestingly, India is self-sufficient in zinc production, while there is a shortage of lead.
- The primary source of zinc and lead production in India is the state of **Rajasthan**, which contributes nearly the entire production output.
- Other regions with substantial lead-zinc ore resources include Andhra Pradesh, Madhya Pradesh, Bihar, and Maharashtra.
- Additionally, Gujarat, Meghalaya, Odisha, Sikkim, Tamil Nadu, Uttarakhand, and West Bengal also have established ore resources.

Gold

- Gold is a dense, soft, malleable, and ductile metal in its purest form. It distinguishes itself as one of the least reactive chemical elements, demonstrating remarkable resistance to corrosion.
- This precious metal can often be found in its native elemental form, existing as nuggets or grains within auriferous rocks, veins, and alluvial deposits.

Zinc

- Zinc is a silvery blue-grey metal with a comparably low melting and boiling point. Its principal ore, sphalerite, is typically found in veins in conjunction with other minerals like **galena and pyrite**.
- Approximately three-fourths of zinc is employed as a protective coating for iron and steel to prevent corrosion, resulting in galvanized steel. It is also widely used as an alloying metal in the production of bronze and brass.
- The remaining one-fourth of zinc is consumed in the form of zinc compounds, primarily by industries such as rubber, chemicals, paints, and agriculture. Interestingly, zinc is not only vital in industrial applications but also plays a crucial role in the growth and development of humans, animals, and plants. In fact, it ranks as the second most common trace metal found naturally in the human body, following iron.

Fig. 3.22: Distribution of Lead & Zinc in India

Gold Reserves in India

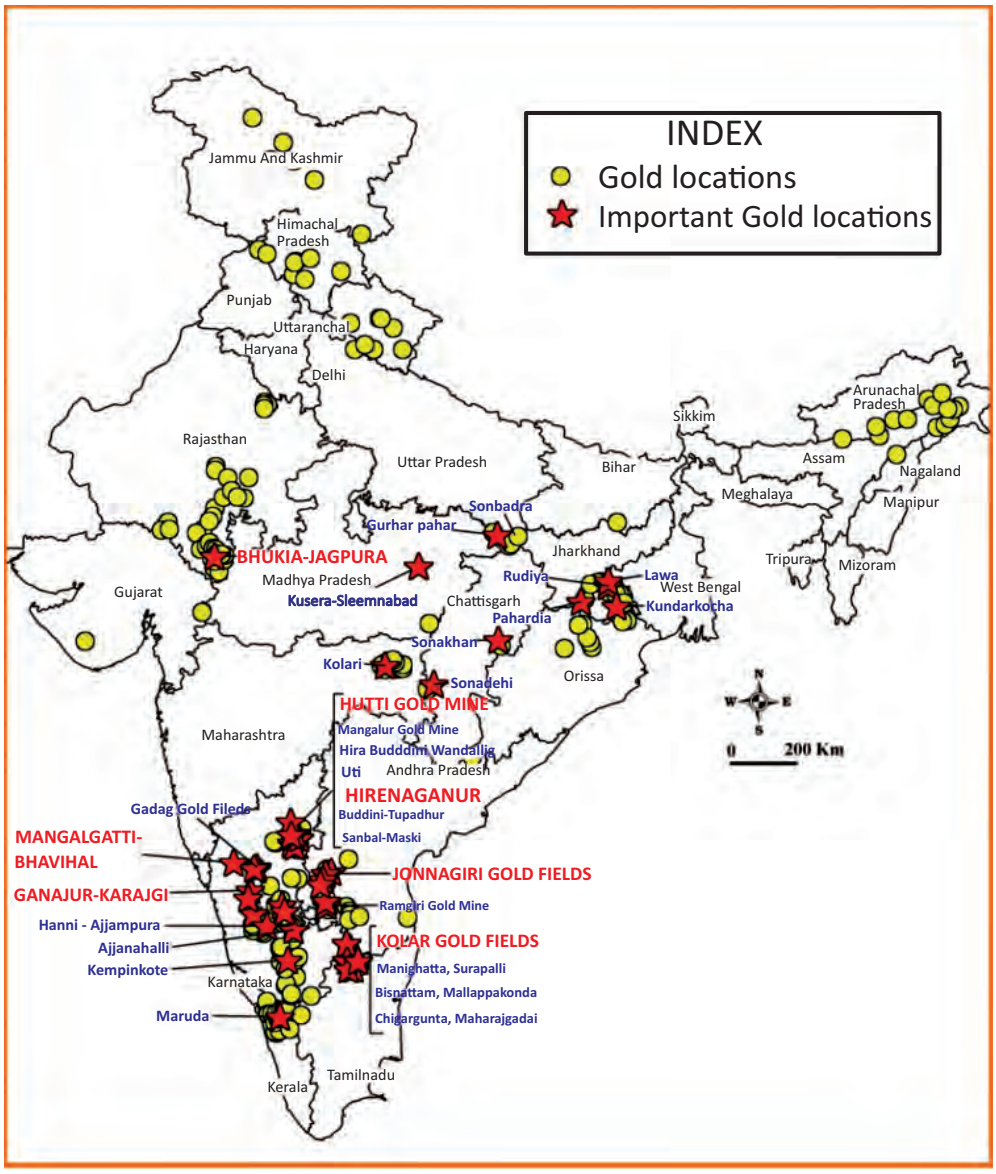


Fig. 3.23: Distribution of gold in India

- As per **National MIneral Inventory**, India possessed an estimated **502 million tonnes(MT) of gold ore reserves** with **654.74 tonnes** of gold metal.
- **Bihar** is endowed with **222.885 million tonnes (44%)** of gold ore containing **37.6 tonnes** of metal.
  - The entire resource of gold ore in Bihar is located in **Sono area of Jamui district.**
- Other major gold ore reserves are distributed across Rajasthan (25%), Karnataka (21%), West Bengal (3%), Andhra Pradesh (3%), Jharkhand (2%).
- The remaining 2% resources of ore are located in Chhattisgarh, Madhya Pradesh, Kerala, Maharashtra and Tamil Nadu.
- Alluvial gold in India is placer gold found in riverbeds, streambeds, and floodplains. Originating from eroded gold-bearing rocks, it is transported by rivers. Notably, river terraces along Punna Puzha and Chabiyar Puzha in Nilambur valley, Kerala, have yielded some alluvial gold.

Silver

- Shifting our focus to silver, it belongs to the category of noble metals, exemplifying exceptional resistance to corrosion, akin to gold and platinum.
- Silver distinguishes itself with the highest electrical and thermal conductivity among all metals. It plays a vital role in printed electric circuits, electroplating for electronic conductors, and alloying with gold and copper for electrical contacts.
- Its chloride and iodide are light-sensitive, making them valuable for photographic materials.
- Additionally, silver in paste form finds application in solar cells. The principal ore minerals of silver encompass stephanite, pyrargyrite, and proustite.

Silver Reserves in India

- When considering silver reserves and production in India, native silver deposits are scarce, with the small Bharak deposit in Rajasthan being an exception.
- Silver is generally found in association with lead, zinc, copper, especially their sulphide ores, and gold ores, extracted as a by-product through electrolysis or chemical methods.
- According to Global Data, India is the world's eleventh-largest producer of silver in 2022, with output down by 0.95% in 2021.
- **Rajasthan** contributes significantly, holding **87% of the reserves** in terms of ore, followed by Jharkhand at 5%, Andhra Pradesh at 3%, and Karnataka at 2%.

Manganese

- Manganese is a hard and brittle element commonly found in association with iron, laterite, and other minerals.
- Manganese is an important raw material for smelting of iron ore and also used for manufacturing ferro alloys.
- The major commercially significant manganese ores include pyrolusite, psilomelane, manganite, and braunite.
- It is widely used to enhance the strength of steel and improve the resistance to corrosion in aluminium alloy cans.
- The iron and steel industry is the primary consumer of manganese ore, using it directly as a blast furnace feed for deoxidizing and desulfurizing steel.
- A substantial portion of manganese is also utilized in the production of manganese alloys like ferromanganese.

Manganese Ore Distribution in India

- In India, manganese ore deposits are primarily metamorphosed sedimentary deposits. Gondite deposits are found in Madhya Pradesh (Balaghat and Chhindwara districts), Maharashtra (Bhandara and Nagpur districts), Gujarat (Panchmahal district), and Odisha (Sundargarh district). Kodurite and Khondolite deposits are found in Odisha (Koraput district) and Andhra Pradesh (Srikakulam district).
- **Odisha has the highest reserve of manganese ore while the maximum manganese producing state is MP.**
- **India is a major importer of manganese ore**, with South Africa, Australia, and Gabon being the primary suppliers.

Copper

- Copper is unique among metals as it naturally occurs in a directly usable metallic form. It is a malleable, ductile metal with high thermal and electrical conductivity. Copper and its alloys find extensive applications in the electrical industry.
- Common copper alloys include brass, bronze, duralumin, and stainless steel. Copper ore mining in India is limited due to its low metal content, making it necessary to import most of the copper needed.

Copper Ore Distribution in India

- Compared to the international average ore metal content of 2.5%, Indian ore exhibits a lower average grade, measuring below 1%.
- **Rajasthan holds the lion's share of copper ore reserves** in India, accounting for approximately 50%, with Madhya Pradesh and Jharkhand following suit.
- The remaining reserves are distributed among Andhra Pradesh, Gujarat, Haryana, Karnataka, Maharashtra, Meghalaya, Nagaland, Odisha, Sikkim, Tamilnadu, Uttarakhand, and West Bengal.
- Regarding production, **Madhya Pradesh takes the lead as the largest copper producer** in India, closely followed by Rajasthan.
- However, despite domestic production efforts, India consistently faces a shortfall in copper ore supply, necessitating imports from other nations. The primary sources of these imports include the USA, Canada, Zimbabwe, Japan, and Mexico.

Nickel

- Nickel is not naturally occurring in its free form but is commonly found in association with other metals like copper and uranium.
- It has unique properties, including low electrical conductivity, high resistance to corrosion, and excellent strength at high temperatures.
- Nickel is used in various applications, including manufacturing armoured plates and as an alloying material.
- Nickel-aluminum alloys are utilized in aerospace and internal combustion engines, while metallic nickel is used in batteries and as a catalyst in hydrogenation processes.

Fig. 3.24: Distribution of Copper Mines in India

Distribution of Nickel in India

- Nickel primarily occurs as oxides, sulphides, and silicates in India. Nickel-rich limonite deposits are prominently located in Odisha's Jajapur district.

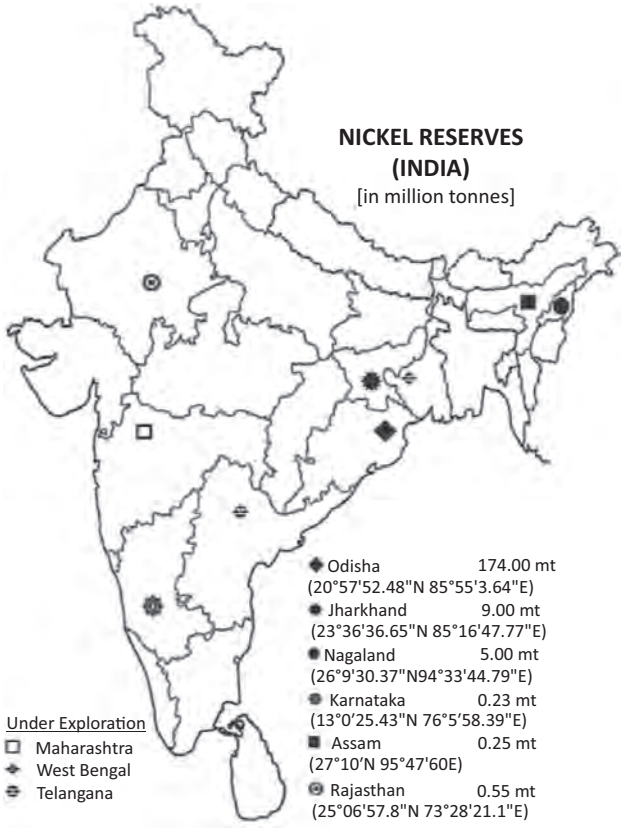


Fig. 3.25: Nickel Reserves in India

- In Jharkhand, nickel is primarily found in its sulphide form. Other significant occurrences of nickel can be observed in Karnataka, Kerala, and Rajasthan.
- The state of Odisha boasts approximately **92% of the total nickel resources**, with the remainder distributed across Jharkhand, Nagaland, and Karnataka.

Cobalt

- Cobalt is a crucial ferromagnetic alloying metal with a wide range of industrial applications. It is often extracted as a by-product of copper, nickel, zinc, or precious metals.
- Cobalt is essential in metallurgical applications, especially in superalloy production, where it provides wear and corrosion resistance at high temperatures. It is also used in rechargeable batteries and powerful magnet manufacturing.
- The cobalt region of India is also highly affected with naxalism due to various political and economic reasons.
- The Democratic Republic of Congo (DRC) has maintained its position as the leading cobalt producer globally, contributing to 73% of the global output in 2022.

Distribution of Cobalt Reserves across India

- While India aggressively pursues electric mobility, including lithium-ion batteries, it must secure resources for strategic minerals like lithium and cobalt.

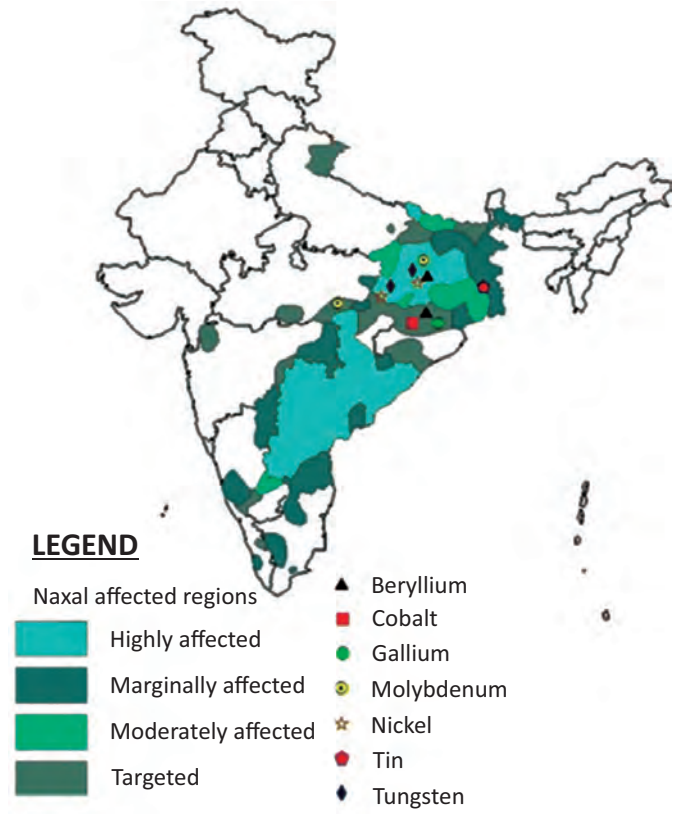


Fig. 3.26: Distribution of cobalt in India

- Cobalt demand is primarily met through imports, with recycling technologies evolving for recovery from waste Li-ion batteries.
- Imports of cobalt and alloys mainly originate from the USA, Canada, Belgium, Norway, the UK, China, and Morocco. In **FY 2023**, around 172 tonnes of cobalt, a critical mineral was imported totally and it, came into the country at a cost of nearly ₹72 crore.

Molybdenum

- Molybdenum is essential as an alloying element in steel, cast iron, nickel, cobalt, titanium, and superalloys to enhance strength and corrosion resistance.
- It is used in electrical and electronic components and plays a role in the energy industry. Molybdenum is sourced from molybdenite, its principal ore, which is typically associated with copper, lead, and zinc ores in India. Despite its importance, India lacks significant molybdenum resources and relies on imports.

Chromite

- Chromite, an iron chromium oxide, is a valuable ore of chromium. Extracted chromium is used in various applications, including chrome plating, alloying for corrosion-resistant superalloys, and the production of nichrome and stainless steel.
- India possesses substantial chromite reserves, with the majority located in Odisha. A minor portion is found in Manipur, Nagaland, and Karnataka. Imports of chrome ore mainly come from South Africa.

Non-Metallic Minerals

Fig. 3.27: Non-metallic minerals in India

Non-metallic minerals in India refer to minerals that do not contain metals, and they are important for various industrial applications, construction, and manufacturing processes.

Coal

Coal is the most important and abundant fossil fuel in India. Coal is mainly used in the generation of thermal power and smelting of iron ore.It accounts for 55% of the country's energy needs. India's industrial heritage was built upon indigenous coal.

Characteristics of Indian Coal:

- Indian coal is notably characterized by its **high ash** content, ranging from **35 to 45** percent, a significantly higher proportion compared to coal found in other regions globally, typically around 15 percent.
- In addition to its high ash content, another factor rendering entrained gasifiers, commonly utilized in Integrated Gasification Combined Cycle (IGCC) plants abroad, unsuitable for Indian coal is its comparatively **high ash fusion temperature** of approximately 1,500 degrees Celsius.
- However, it's noteworthy that Indian coal exhibits a relatively **low sulfur content**, approximately **0.5 percent**.

Sources

India has the **fifth-largest** coal reserves in the world. Coal occurs in rock sequences mainly of two geological ages, namely Gondwana and tertiary deposits:

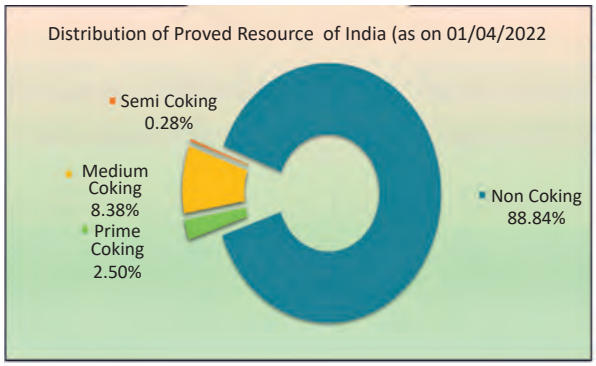

Distribution of Proved Resource of India (as on 01/04/2022
Semi Coking 0.28%
Medium Coking 8.38%
Prime Coking 2.50%
Non Coking 88.84%

Fig. 3.28: Proportion of coking and non-coking coal in India

1. **Gondwana Coal:** Gondwana coal, also known as metallurgical coal, is older and forms the bulk of India's coal reserves. These coal deposits were formed during the Permian period around **250 to 300 million years ago.** They are found mainly in the eastern and central regions of India, particularly in states like Jharkhand, Odisha, Chhattisgarh, West Bengal, and Madhya Pradesh.
2. **Tertiary Coal:** Tertiary coal, also known as non-metallurgical or lignite coal, is younger and comparatively less abundant than Gondwana coal. These deposits were formed more recently, during the Tertiary period around **15 to 60 million years ago**. Tertiary coal is primarily found in Assam, Arunachal Pradesh, Meghalaya, Nagaland and southern part of India, particularly in the states of Tamil Nadu and Gujarat.

Formation	Proved Measured	Indicated	Inferred	Total
Gondwana Coals	148194	139065	30174	317433
Tertiary Coals	594	99	895	1588
Grand Total	148787	139164	31069	319020

Fig. 3.29: Quantity of Gondwana and Tertiary coal resources in India

Distribution

- **Over 97 percent** of coal reserves occur in the valleys of **Damodar, Son, Mahanadi and Godavari.**
- The most important **Gondwana coal fields of India** are located in Damodar Valley.
  - They lie in the Jharkhand-Bengal coal belt and the important coal fields in this region are Raniganj, Jharia, Bokaro, Giridih, Karanpura.
  - **Jharia is the largest coal field followed by Raniganj.** The other river valleys associated with coal are Godavari, Mahanadi and Sone.
- The most important coal mining centres are Singrauli in Madhya Pradesh (part of Singrauli coal field lies in Uttar Pradesh), Korba in Chhattisgarh, Talcher and Rampur in Odisha, Chanda–Wardha, Kamptee and Bander in Maharashtra and Singareni in Telangana and Pandur in Andhra Pradesh.
- **Tertiary coals occur in Assam, Arunachal Pradesh, Meghalaya and Nagaland.**
  - It is extracted from Darangiri, Cherrapunji, Mewlong and Langrin (Meghalaya); Makum, Jaipur and Nazira in upper Assam, Namchik – Namphuk (Arunachal Pradesh) and Kalakot (Jammu and Kashmir).

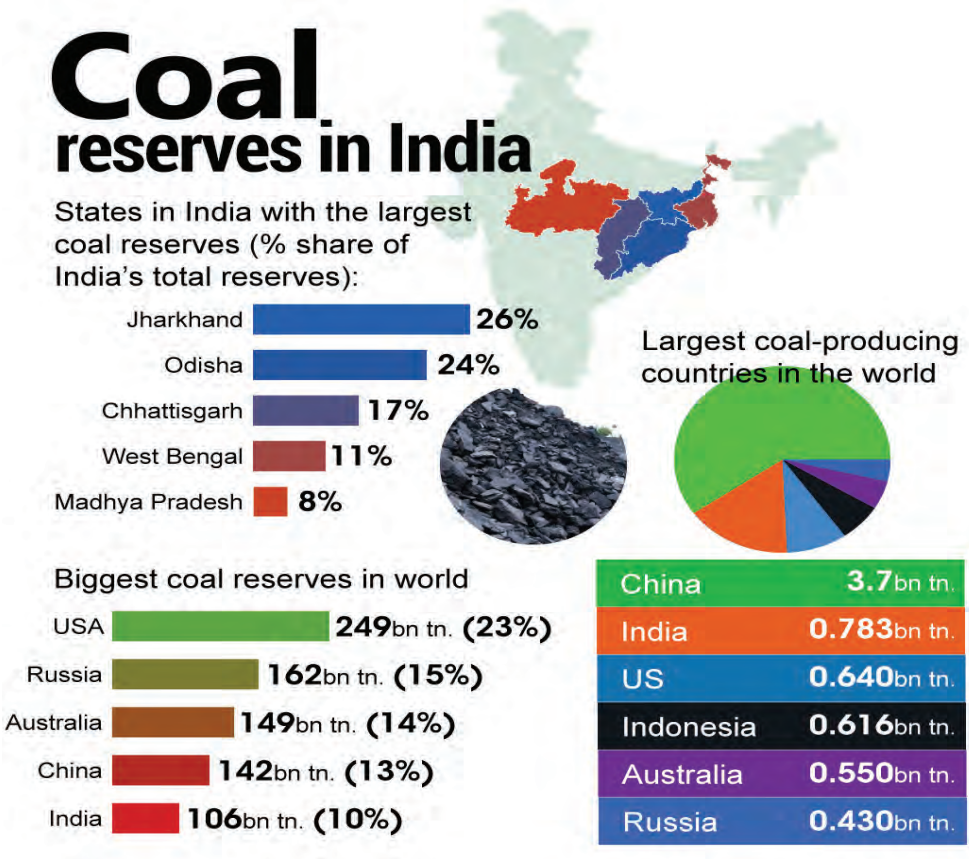


Fig. 3.30: Distribution of coal reserves in India

- **Brown coal or lignite** occurs in the coastal areas of Tamil Nadu, Pondicherry, Gujarat and Jammu and Kashmir.

Production

- India is the **second-largest producer** of coal in the world, after China.
- The all India coal production in the Financial Year 2021-2022 & 2022-2023 stood at 778.21 Million Tonne (MT) & 893.19 MT (provisional) respectively.
- The major coal producing States in the country are Odisha, Chhattisgarh, Jharkhand, Madhya Pradesh, Telangana, Maharashtra & West Bengal.
- The largest coal producing state in India is **Jharkhand**, followed by Odisha and Chhattisgarh (2023).

Coal Imports

- India imports the largest share of coal from Indonesia (both Coking and non-coking coal) with a share of 46.21%.

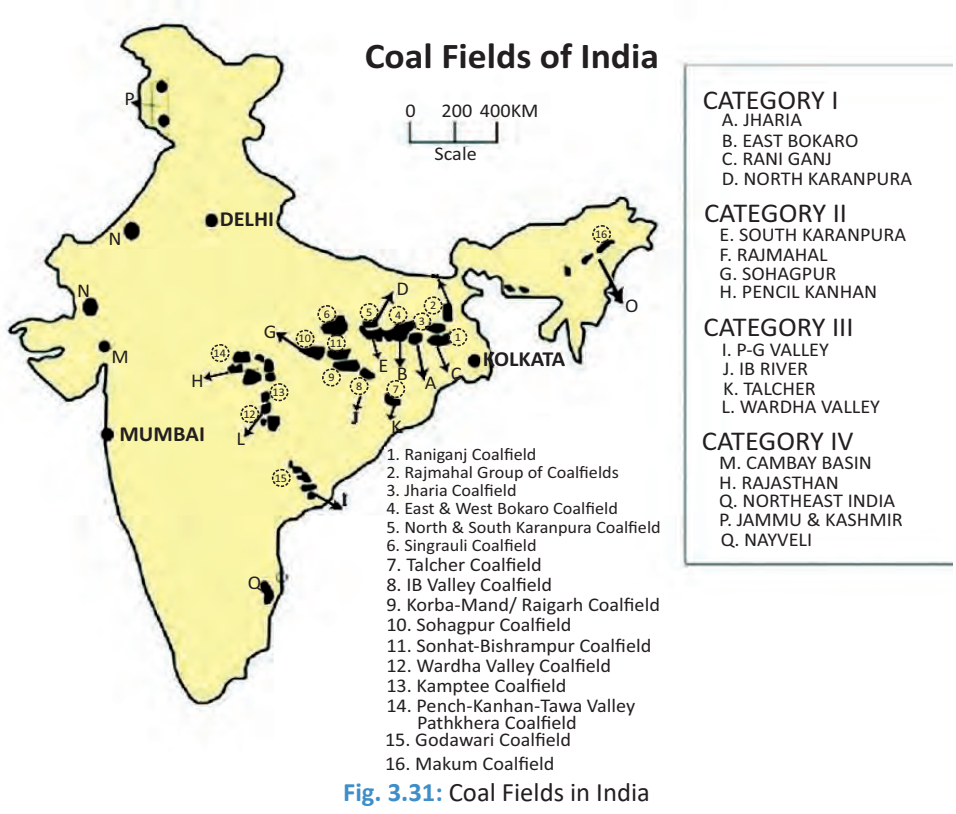


Fig. 3.31: Coal Fields in India

- India imports the largest share of coking coal from Australia with a share of 53.7%.
- India imports the largest share of non-coking coal from Indonesia with a share of 59.24%,

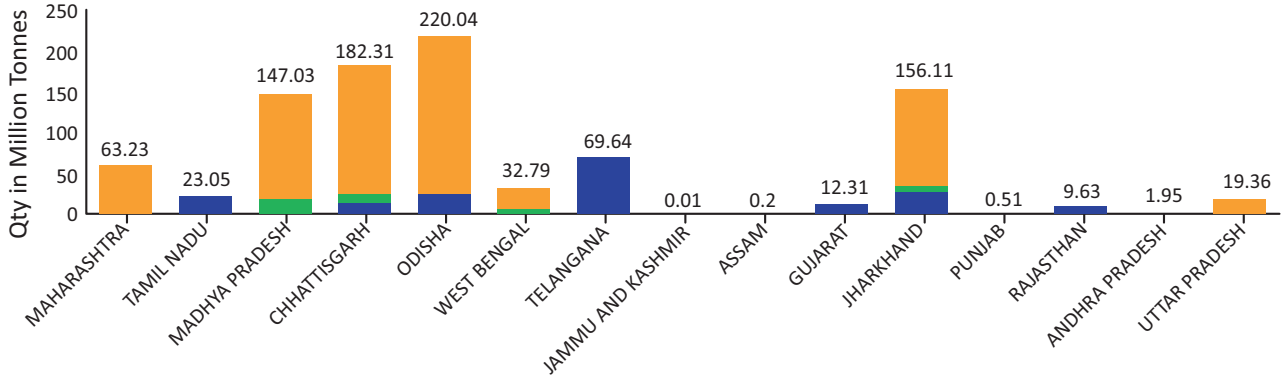


Fig. 3.32: State Wise production of coal in India

Source Country-Wise Import of Coal to India during 2022-23		
Country	Quantity [In MT]	Share%
Indonesia	109.828	46.21
Australia	47.498	19.98
Russia	21.342	8.98
South Africa	17.445	7.34
USA	13.692	5.76
Singapore	10.074	4.24
Mozambique	9.174	3.86
Others	8.615	3.63
Total	**237.668**	**100.00**

Source Country-Wise Import of Non-Coking Coal to India during 2022-23		
Country	Quantity [In MT]	Share%
Indonesia	107.594	59.24
South Africa	17.445	9.61
Australia	17.398	9.58
Russia	16.861	9.28
Mozambique	7.092	3.91
USA	6.418	3.53
Others	8.807	4.85
Total	**181.615**	**100**

Source Country-Wise Import of Non-Coking Coal to India during 2022-23		
Country	Quantity [In MT]	Share%
Australia	30.1	53.7
USA	7.274	12.98
Singapur	5.399	9.63
Russia	4.481	7.99
Canada	2.896	5.17
Indonesia	2.234	3.99
Mozambique	2.081	3.71
Others	1.588	2.83
Total	**56.053**	**100**

Fig. 3.33: Source Country-wise Coal Import by India (2022-23)

Coal Exports

- **Nepal** is the largest export destination of coal from India with a share of 71.61%.
- Other major export destinations include Bangladesh and Bhutan.

Export of Coal by India to Different Countries during 2022-23		
Country	Quantity [In MT]	Share%
Nepal	0.833	71.61
Bangladesh PR	0.245	21.04
Bhutan	0.053	4.56
Others	0.032	2.79
Total	**1.163**	**100.00**

Fig. 3.34: Source Country-wise Coal Export by India(2022-23)

Applications

- **Electricity Generation:** Coal is the primary source of energy for electricity generation in India. Thermal power plants, fueled by coal, produce a significant portion of the country's electricity.
- **Industrial Use:** Industries such as steel, cement, and manufacturing rely on coal as a fuel and raw material. Coal is used in steelmaking (coking coal) and as a source of heat in various industrial processes.
- **Domestic Use:** In rural areas, coal is used for cooking and heating purposes, particularly in households without access to cleaner fuels like LPG or electricity.

Challenges

- **Environmental Impact:** Coal combustion releases pollutants such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM), and carbon dioxide (CO_2), contributing to air pollution and greenhouse gas emissions. This poses significant environmental and public health challenges, including respiratory illnesses and climate change.
- **Resource Depletion:** Coal reserves in India are finite, and continued extraction could lead to resource depletion over time. Sustainable management of coal resources is essential to ensure their availability for future generations.
- **Health Impacts:** Coal mining and combustion activities can have adverse health effects on workers and communities, including respiratory diseases, cardiovascular issues, and accidents in mines.
- **Land Use and Displacement:** Coal mining operations often require large areas of land, leading to habitat destruction, deforestation, and displacement of local communities. This can result in social unrest and conflicts over land rights.
- **Water Usage and Pollution:** Coal mining and power generation processes require significant amounts of water for extraction, processing, and cooling. This can lead to water pollution and strain on water resources, especially in water-stressed regions.
- **Transition to Cleaner Alternatives:** There is a global push towards cleaner and renewable energy sources to mitigate climate change and reduce dependence on fossil fuels. India faces the challenge of transitioning away from coal towards cleaner alternatives while ensuring energy security and economic development.
- **Import Dependence:** Despite having significant coal reserves, India relies on coal imports to meet its growing demand, particularly for high-quality coal used in industries like steel manufacturing. This import dependence exposes the country to supply disruptions and price fluctuations in the global coal market.

In Million Tonnes

Coal	2019-20	2020-21	2021-22	2022-23	2023-24*
Coking Coal	51.83	51.2	57.16	56.05	38.94
Non-Coking Coal	196.7	164.05	151.77	181.62	135.45
Total Coal Import	248.53	215.25	208.93	237.67	174.39
Coke	2.88	2.46	2.48	3.63	2.44

*Import upto Nov, 2023 (Source:-DGCI & S)

Fig. 3.35: Coal Import Trends by India

Inevitability of Coal Mining Despite Environmental Impacts:

Despite the environmental repercussions, numerous proponents argue that coal mining remains essential for fostering development. Let's explore the reasons behind this perspective

- **Energy Security and Needs**: Coal remains the most abundant and widely used fossil fuel, providing a reliable and affordable source of energy crucial for sustaining economic growth and development globally.
- **Job Creation**: Coal mining serves as a significant source of employment, offering job opportunities for millions of individuals across various sectors including mining, transportation, and associated industries, thus contributing to livelihoods and socioeconomic stability.
- **Infrastructure Development:** The extraction of coal necessitates the development of vital transportation infrastructure such as railways, roads, and ports, fostering regional development and bolstering economic growth through improved connectivity and accessibility.
- **Revenue Generation:** Coal mining generates substantial revenue for governments through taxes, royalties, and other fees. These funds play a pivotal role in financing essential social welfare programs, education, healthcare, and infrastructure projects vital for societal progress.
- **Utilization of Renewable Energy:** While renewable energy sources hold promise for the future, the transition towards widespread adoption has been gradual. In the interim, coal continues to play a crucial role in meeting energy demands, especially in regions where renewable energy infrastructure is still developing.

Way Forward

- **Commercial Mining:** In 2020, the Indian government launched the auction process for commercial coal mining, marking a significant shift from the earlier regime of captive mining.
  - This move attracted private investments and participation, with companies like Adani Enterprises and Hindalco winning bids for coal blocks.
  - This step aimed to increase domestic coal production, enhance competition, and bring in advanced mining technologies.
- **Coal Import Substitution:** India's coal production witnessed a steady increase over the years, aiming to reduce reliance on coal imports.
  - For instance, **Coal India Limited (CIL),** the largest coal producer in India, intensified its production efforts, targeting to meet the growing demand domestically and minimize imports.
  - The target of all India coal production has been fixed at **1017 Million Ton (MT)** for the financial year 2023-24.
- **Power Sector Linkage Policy - SHAKTI:** The SHAKTI scheme (Scheme for Harnessing and Allocating Koyala Transparently in India) was introduced to ensure the availability of coal for power plants through a transparent auction process.
  - Under this policy, coal linkages were allocated to power plants based on a transparent bidding mechanism, ensuring a reliable fuel supply for the power sector.
- **Rationalization of Coal Linkages:** The rationalization of coal linkages aimed to optimize coal transportation and distribution.
  - For instance, the implementation of the "Pooled Route" mechanism by Indian Railways helped in rationalizing coal movement, reducing empty wagon movements, and ensuring efficient utilization of resources.
- **Third-Party Sampling:** The introduction of third-party sampling in coal quality assessment enhanced transparency and credibility in the coal supply chain.
  - Independent agencies were appointed to conduct coal quality checks, ensuring adherence to specified standards and preventing malpractices in coal quality reporting.
- **First Mile Connectivity:** Initiatives like the construction of dedicated coal corridors and rail connectivity projects improved first-mile connectivity.
  - **Example**: **The Sagarmala Project** of the Ministry of Ports, Shipping and Waterways aimed to develop port infrastructure and enhance connectivity for efficient coal transportation from mines to ports.
- **Coal Export in Neighboring Countries:** India explored opportunities to export coal to neighboring countries like Bangladesh and Nepal.
  - **Example**: India signed agreements with Bangladesh for the export of coal from Meghalaya and Assam, supporting regional energy cooperation and fulfilling the energy needs of neighboring nations.
- **Corporate Social Responsibility (CSR):** Coal companies like Coal India Limited (CIL) engaged in various CSR initiatives.
  - **Example**: CIL undertook projects related to education, healthcare, infrastructure development, and environmental conservation in coal-mining regions, benefiting local communities and promoting sustainable development alongside coal production activities.
- **Dedicated Freight Corridors:** Ministry of Railways has taken up construction of two Dedicated Freight Corridors (DFC) viz. **Eastern Dedicated Freight Corridor (EDFC) from Ludhiana to Sonnagar (1337 Km) and the Western Dedicated Freight Corridor (WDFC) from Jawaharlal Nehru Port Terminal (JNPT) to Dadri (1506 Km).**
  - Construction of EDFC has been fully completed and 1176 KM out of 1506 KM of WDFC has been completed.
    - The Eastern DFC will mainly cater to coal, Cement, Finished steel and other bulk commodities.
    - Eastern DFC will facilitate **faster evacuation of coal** from the eastern part of the country for the Thermal Powerhouses located in northern hinterland.

Commercial coal mining in India

- **Commercial coal mining** refers to the process of coal extraction conducted by private sector companies for commercial purposes, rather than solely by government-owned entities like Coal India Limited.
- In India, commercial coal mining was largely restricted to government-controlled entities until recent years.

The Coal Mines (Special Provisions) Act, 2015

The Coal Mines (Special Provisions) Act, 2015, was enacted to facilitate the allocation of coal mines through a transparent bidding process and promote competition in the coal sector.

Salient features of the Act:

- **Auction Mechanism:** The Act introduced a transparent auction process for the allocation of coal mines to private sector companies for commercial mining purposes. The auctions are conducted by the government through competitive bidding, ensuring fair and efficient allocation of coal blocks.
- **Allotment of Coal Blocks:** The Act allows for the allotment of coal blocks for mining to private companies for specified end-uses such as power generation, steel production, and other commercial purposes. These allotments are made through a competitive bidding process to ensure transparency and efficiency.

- **Revenue Sharing:** Under the Act, successful bidders are required to share a percentage of their revenue from coal mining operations with the government. This revenue-sharing mechanism ensures that the government receives a fair return on the extraction of coal resources.
- **Cancellation of Previous Allocations:** The Act provided for the cancellation of coal block allocations made through the earlier process of allocation by the government, which was deemed non-transparent and subject to controversy.

Petroleum

- Crude petroleum consists of hydrocarbons of liquid and gaseous states varying in chemical composition, colour and specific gravity.
- It is an essential source of energy for all internal combustion engines in automobiles, railways and aircraft.
- Its numerous by-products are processed in petrochemical industries such as fertiliser, synthetic rubber, synthetic fibre, medicines, vaseline, lubricants, wax, soap and cosmetics.

Petroleum Sector in India: Some Stats

- 3rd largest energy and oil consumer in the World
- 4th largest importer of liquefied natural gas (LNG).
- Largest exporter of petroleum products in Asia since 2009 (FY 20-21)
- 4th largest global refiner of crude oil
- Largest LPG Consumer in the world
- India consumed 172.7 MMT petroleum products and 49.5 BCM natural gas in April-Dec '23, making a growth of 4.9% and 9.2% over the April-Dec'22.
- As of April 2022, estimated reserves of crude oil in India stood at 651.77 mn tonnes, and natural gas stood at 1138.67 bn cubic meters.
- India has set a target to raise the share of natural gas in the energy mix to 15% by 2030 from about 6.7% now.

Sources and Distribution

- Crude petroleum is typically found in **sedimentary rocks of tertiary period.**
- Petroleum in India primarily comes from both **onshore and offshore sources**:

- **Onshore Sources:** Onshore petroleum reserves are found in sedimentary basins across various regions of India.
  - **Major onshore oil-producing areas:**
    - **Assam**: Assam has been a significant oil-producing region since the early 20th century, with fields like Digboi, Naharkatiya, and Moran being important contributors to domestic production.
    - **Gujarat**: Gujarat is another major onshore oil-producing state, with fields like Ankleshwar, Kalol, Mehsana, and others contributing significantly to India's petroleum output.
    - **Rajasthan**: The state of Rajasthan has emerged as a significant onshore oil-producing region in recent years, with the discovery of the Barmer basin and the Mangala field.
    - **Tamil Nadu:** Tamil Nadu has onshore oil fields, particularly in the Cauvery basin, where oil and gas exploration and production activities are ongoing.
- **Offshore Sources:** India also has substantial offshore petroleum reserves located in its territorial waters in the Arabian Sea, Bay of Bengal, and the Andaman Sea.

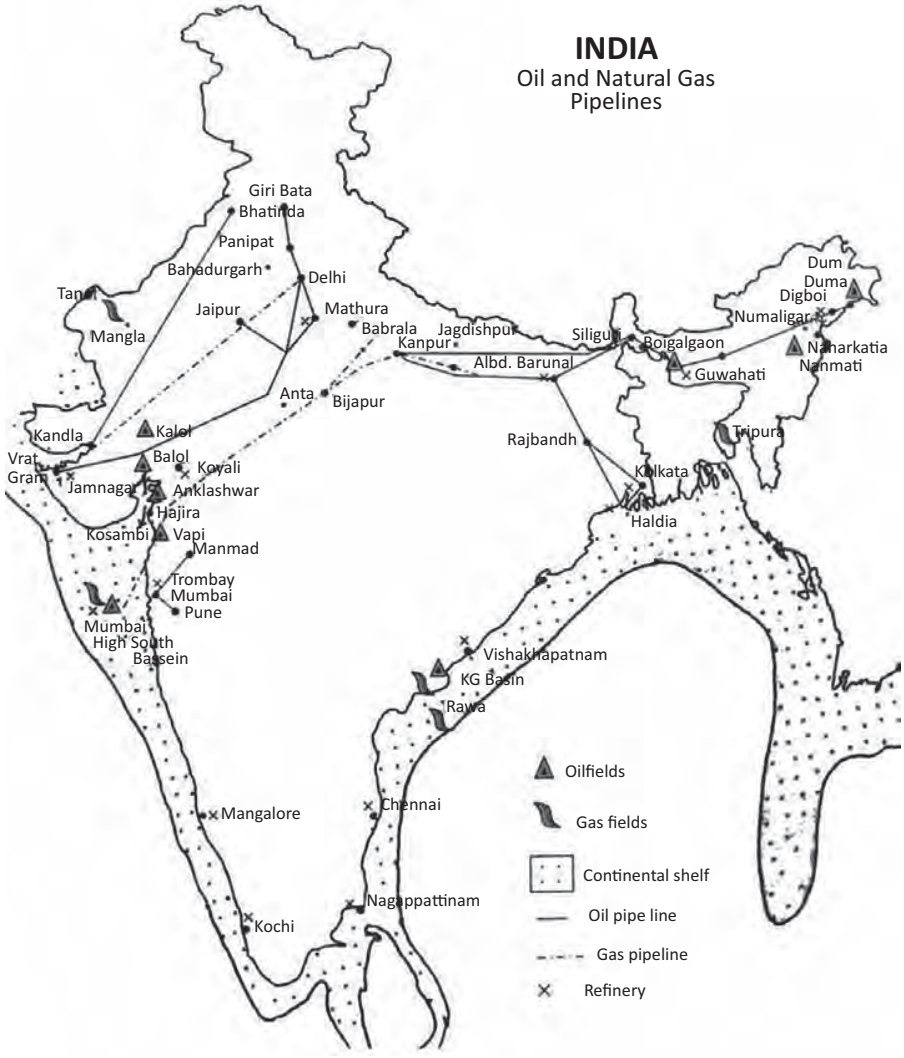


Fig. 3.36: Onshore and offshore sources of petroleum (crude oil) in India

- **Major offshore oil-producing areas**:
  - **Mumbai High:** Mumbai High, discovered in 1974, is one of the largest and most productive offshore oil fields in India, located in the Arabian Sea off the coast of Mumbai.
  - **Krishna-Godavari Basin:** This offshore basin on the east coast of India has emerged as a significant hydrocarbon province, with several oil and gas discoveries made in recent years.
  - **Cauvery Basin:** The offshore Cauvery basin, extending from Tamil Nadu to Kerala, has also seen oil and gas exploration activities, with some discoveries made in the region.

Strategic Petroleum Reserves in India
❑ Strategic Petroleum Reserves are underground storage facilities where crude oil is stockpiled to be used during emergencies like supply disruptions or price spikes. ❑ The underground SPR storages have a total capacity of 5.33 Million Metric Tonnes (MMT) of crude oil and are located in: (i) Vishakhapatnam in Andhra Pradesh (1.33 MMT), (ii) Mangaluru in Karnataka (1.5MMT) (iii) Padur in Karnataka (2.5 MMT) ❑ The SPRs are operated by the **Indian Strategic Petroleum Reserves Limited (ISPRL)**, a special purpose vehicle created by the Government of India. ISPRL is responsible for the construction, operation, and maintenance of the SPR facilities. ❑ The Government had approved the establishment of two additional commercial-cum-strategic facilities with total storage capacity of 6.5 MMT at **Chandikhol** (4 MMT) in Odisha and **Padur** (2.5 MMT) in Karnataka, on a Public Private Partnership (PPP) mode.

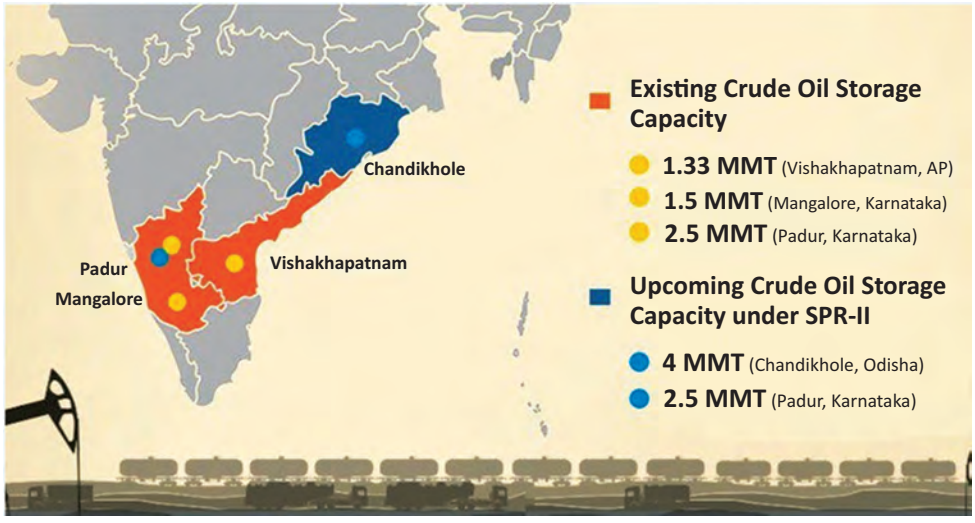


Fig. 3.37: Strategic Petroleum Reserves in India

Oil Refineries in India

- ❑ Oil extracted from the wells is crude oil and contains many impurities. It cannot be used directly and needs to be refined.
- ❑ There are two types of refineries in India: (a) field based and (b) market based.
- ❑ Digboi is an example of field based and Barauni is an example of market based refinery.
- ❑ There are total **23 refineries** in the country. Of these, 18 are in the Public Sector, 2 in the Joint Venture and 3 in the Private Sector which are well spread geographically and connected with cross country pipelines.

Production (State-wise)

- ❑ **Maharashtra:** Maharashtra has oil and gas fields located offshore in the Mumbai High region, contributing to the state's petroleum production.
  - **Mumbai High** is one of the most significant offshore oil and gas fields in India with a share of **65.28%** in petroleum production in India.
- ❑ **Gujarat:** Gujarat is another major contributor to India's petroleum production. It is home to several oil and gas fields, including the **Ankleshwar, Kalol, and Cambay fields**.
  - The state also houses major refineries like the **Jamnagar Refinery,** one of the largest in the world.
- ❑ **Assam:** Assam is one of the leading states in petroleum production in India. It hosts the **Digboi oil field,** one of the oldest oil fields in the country, as well as other fields like **Naharkatiya, Moran, and Duliajan.**
- ❑ **Tamil Nadu:** Tamil Nadu hosts oil and gas fields in the Cauvery Basin, contributing to the state's petroleum production.

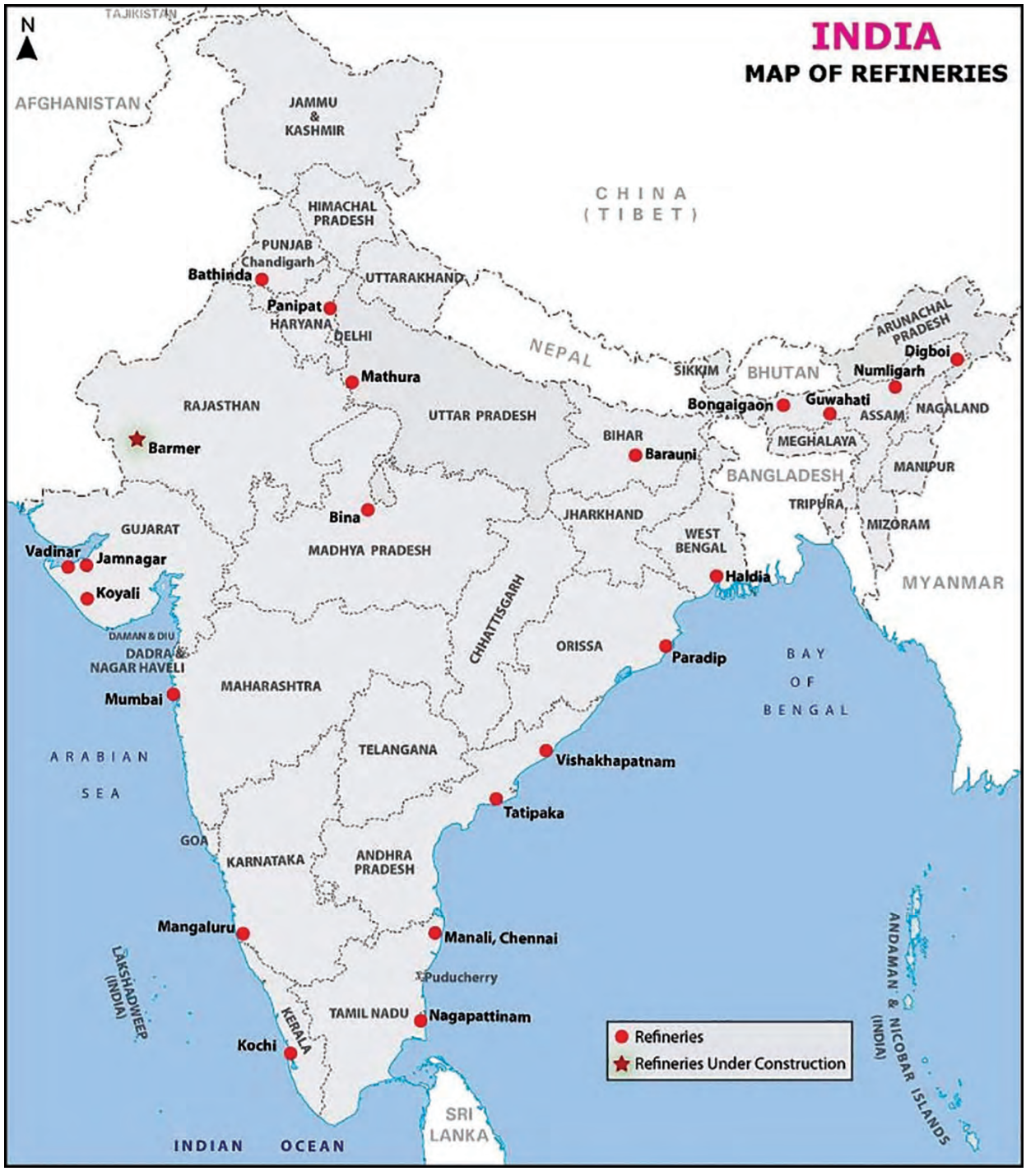


Fig. 3.38: Oil Refineries in India

- The **Nagapattinam and Cauvery fields** are notable in this region.

❑ **Andhra Pradesh:** Andhra Pradesh has oil and gas fields located offshore in the Krishna-Godavari Basin.

- The state contributes to India's petroleum production through fields like the KG-D6 block, operated by Reliance Industries.

❑ **Rajasthan:** Rajasthan has emerged as a significant player in petroleum production, particularly due to the discovery of the Barmer Basin.

- The Barmer Basin hosts the Mangala, Bhagyam, and Aishwariya fields, operated by Cairn India (now part of Vedanta Limited).

Apart from these states, ongoing exploration activities are being conducted in various other regions across the country, including the northeastern states, Gujarat onshore, Kerala-Konkan Basin, and offshore areas in the Arabian Sea and Bay of Bengal, with the aim of discovering new oil and gas reserves.

States	Percentage
Mumbai High	65.20
Gujarat	18.28
Assam	14.09
Tamil Nadu	1.19
Andhra Pradesh	0.93
Arunachal Pradesh	0.23

Fig. 3.39: Share of states in production of petroleum

Applications

- **Transportation Fuel:** Petroleum fuels such as petrol and diesel are the primary sources of energy for transportation in India. They power cars, trucks, buses, motorcycles, and other vehicles, facilitating mobility and economic activities.
- **Industrial Use:** Petroleum products serve as essential inputs for various industries, including manufacturing, construction, agriculture, and aviation. They are used as fuels, lubricants, solvents, and raw materials in industrial processes.
- **Power Generation:** Petroleum fuels are used in power plants, particularly during peak demand periods or in areas with limited access to other energy sources. However, their contribution to electricity generation is relatively small compared to coal and renewable energy sources.
- **Domestic Consumption:** Petroleum products like liquefied petroleum gas (LPG) are widely used for cooking and heating purposes in households across India, particularly in urban areas.

Challenges

- **Import Dependency:** India relies heavily on imports to meet its petroleum needs, making it vulnerable to supply disruptions and price volatility in the global market. This import dependency poses challenges to energy security and economic stability.
- **Environmental Pollution:** The combustion of petroleum fuels releases pollutants such as sulfur dioxide (SO2), nitrogen oxides (NOx), particulate matter (PM), and carbon dioxide (CO2), contributing to air pollution, climate change, and public health concerns.
- **Resource Depletion:** Petroleum reserves are finite, and continued extraction could lead to resource depletion over time. Sustainable management of petroleum resources is essential to ensure their availability for future generations.
- **Price Fluctuations:** Global oil prices are subject to fluctuations due to geopolitical tensions, market speculation, supply-demand dynamics, and other factors. These price fluctuations can have significant economic implications for India, affecting inflation, fiscal balance, and trade deficits.
- **Climate Change Mitigation:** Petroleum consumption is a major contributor to greenhouse gas emissions, driving climate change and environmental degradation. India faces pressure to transition towards cleaner and renewable energy sources to mitigate its carbon footprint and meet international climate commitments.
- **Energy Transition:** There is a growing recognition of the need to diversify the energy mix and reduce dependence on fossil fuels like petroleum. India faces the challenge of transitioning towards sustainable energy sources while ensuring energy security, economic growth, and social development.

Way Forward

1. **Diversification of Energy Sources:** India should focus on diversifying its energy mix by increasing the share of renewable energy sources such as solar, wind, and hydroelectric power. This will reduce reliance on petroleum and other fossil fuels, mitigate environmental impacts, and enhance energy security.

   Example: Initiatives like the **National Solar Mission** and the **Wind Energy Mission** aim to promote renewable energy deployment and reduce dependence on conventional fuels.India has set ambitious targets for renewable energy deployment. For instance, the government aimed to achieve 175 GW of renewable energy capacity by 2022, including 100 GW of solar power and 60 GW of wind power, of this target more than 120 GW had been achieved as on June 2022. These efforts are supported by initiatives like the Solar Energy Corporation of India (SECI) auctions, which have led to significant investments in solar power projects across the country.
2. **Enhanced Efficiency and Conservation:** Implementing measures to improve energy efficiency and promote energy conservation across sectors can reduce petroleum consumption and greenhouse gas emissions.

   Example: The Perform, Achieve, and Trade (PAT) scheme under the National Mission for Enhanced Energy Efficiency (NMEEE) has been successful in improving energy efficiency in industries. PAT scheme incentivize industries to adopt energy-efficient technologies and practices. Also, the Bureau of Energy Efficiency (BEE) has implemented energy efficiency measures in sectors such as cement, steel, and thermal power plants, resulting in substantial energy savings.
3. **Investment in Clean Technologies:** Encouraging the adoption of cleaner and more efficient technologies in petroleum refining, transportation, and end-use sectors is crucial. The government can incentivize research, development, and deployment of technologies such as cleaner fuels, electric vehicles, and carbon capture and storage (CCS) to reduce emissions and enhance sustainability.

   Example: The Faster Adoption and Manufacture of Electric Vehicles (FAME) scheme aims to accelerate the

adoption of EVs in India. Initiatives like subsidies for EV purchases, incentives for manufacturers, and setting up charging infrastructure have been rolled out to promote clean transportation alternatives.

4. **Policy Reforms and Regulation:** Strengthening regulatory frameworks and policies related to petroleum exploration, production, refining, pricing, and distribution is essential for promoting transparency, efficiency, and accountability in the sector. Initiatives like the New Exploration Licensing Policy (NELP) aim to attract investment and enhance domestic production of oil and gas.

   Example: New Exploration Licensing Policy (NELP): The government has introduced policy reforms in the petroleum sector to attract investment and enhance domestic production. NELP, launched in 1997, introduced a revenue-sharing model and offered exploration and production rights to both domestic and international companies to boost oil and gas exploration activities in India.

5. **Promotion of Biofuels:** Accelerating the development and adoption of biofuels as an alternative to petroleum can help reduce greenhouse gas emissions, promote rural development, and enhance energy security. The government's Biofuel Policy aims to promote the production and use of biofuels such as ethanol and biodiesel through blending mandates, incentives, and supportive infrastructure.

   Example: India has implemented an Ethanol Blending Program to promote the blending of ethanol with petrol. The program mandates the blending of ethanol with petrol to reduce dependence on fossil fuels, enhance energy security, and mitigate air pollution. Various state governments and oil marketing companies have initiated pilot projects and introduced blending targets to promote ethanol usage.

Exploration and Licensing Policies in India - NELP and HELP

In India, HELP (Hydrocarbon Exploration and Licensing Policy) and NELP (New Exploration Licensing Policy) are both policies introduced by the government to promote exploration and production activities in the hydrocarbon sector, including oil and natural gas.

NELP (New Exploration Licensing Policy)

- NELP was introduced in 1997 as a significant departure from the earlier system of administering exploration blocks through government nominations.
- Under NELP, exploration and production blocks are offered to private and foreign companies through a competitive bidding process.
- The policy aimed to attract investment, technology, and expertise from domestic and international players to explore and develop India's hydrocarbon resources.
- NELP led to increased exploration activity and significant discoveries in India's sedimentary basins, contributing to the country's hydrocarbon production.

HELP (Hydrocarbon Exploration and Licensing Policy)

- HELP was introduced in 2016 to replace the existing NELP regime, with the objective of simplifying and streamlining the regulatory framework for hydrocarbon exploration and production.
- Under HELP, the exploration and production regime was shifted from a production-sharing model to a revenue-sharing model.
- The policy aimed to provide greater flexibility to investors, reduce administrative hurdles, and enhance transparency and accountability in the sector.
- HELP also introduced the concept of Open Acreage Licensing Policy (OALP), which allows investors to nominate blocks for exploration and development at any time.
- Additionally, HELP incorporated provisions for the exploration and development of unconventional hydrocarbons such as shale gas and coal bed methane.

Both NELP and HELP have played crucial roles in attracting investment, promoting exploration activities, and accelerating hydrocarbon production in India. They have contributed to the growth and development of the country's oil and gas sector while ensuring transparency, competitiveness, and efficiency in the allocation of exploration blocks.

Limestone

- Limestone, characterized by its association with rocks composed of calcium carbonate, is primarily of sedimentary origin and is present in geological sequences ranging from pre-Cambrian to recent, with the exception of the Gondwana period.
- Karnataka holds the mantle as the leading state, possessing 28% of India's total limestone resources, closely followed by Andhra Pradesh, Rajasthan, Gujarat, Meghalaya, and Chhattisgarh.
- Over three-fourths of India's total limestone production is contributed by six states, including Andhra Pradesh, Telangana, Rajasthan, Madhya Pradesh, Gujarat, Tamil Nadu, and Karnataka.

Dolomite

- Dolomite, defined by its magnesium content exceeding 10%, is a valuable resource for various applications, notably in metallurgy as refractories and as a flux in blast furnaces.
- This resource is distributed across states, including Madhya Pradesh (29%), Andhra Pradesh, Chhattisgarh, Odisha, Karnataka, Gujarat, Rajasthan, and Maharashtra.
- Chhattisgarh emerges as the largest dolomite-producing state in India, contributing over 30% of the country's total production.

Asbestos

- Asbestos, highly prized for its fibrous structure, filament fragmentation capacity, and exceptional tensile strength, holds great commercial value.
- Asbestos comprises a group of six naturally occurring fibrous silicate minerals. Its commercial significance arises from exceptional physical properties, including flexibility, high tensile strength, and remarkable resistance to electricity, fire, and corrosion by acids.
- Commercial asbestos can be categorized into two primary mineralogical groups: Chrysotile (serpentine) asbestos and amphibole asbestos. Among these, chrysotile asbestos stands out for its superior physical characteristics.
- It finds extensive use in manufacturing fire-resistant materials like cloth and rope.
- Additionally, asbestos cement products such as sheets, pipes, and tiles are employed in various construction applications.
- The bulk of India's asbestos production comes from Rajasthan and Andhra Pradesh, with minor contributions from Jharkhand, Madhya Pradesh, Chhattisgarh, Tamil Nadu, Gujarat, Uttarakhand, and Nagaland.

Kyanite

- Kyanite is commonly found in metamorphic aluminous rocks and holds significant importance in various industries such as metallurgy, ceramics, refractories, glass, and cement due to its exceptional heat-resistant properties.
- Additionally, it is a crucial component in manufacturing spark plugs for automobiles. Notably, in India the quality of kyanite grades is directly linked to their aluminium content; higher aluminium content corresponds to superior quality.
- India has the **world's largest deposit** of kyanite, with **Andhra Pradesh** alone accounting for more than 78% of the resources, followed by Karnataka (13%) and Jharkhand (6%). The remaining 3% of resources are distributed in Kerala, Maharashtra, Rajasthan, Tamil Nadu, and West Bengal.
- In terms of production, **Jharkhand is the largest producer of kyanite**, followed by Maharashtra.

Gypsum

- Gypsum, a hydrated sulfate of calcium, occurs in sedimentary formations such as limestones, sandstones, and shales.
- It finds extensive use in ammonia sulfate fertilizer production, the cement industry, and in the manufacturing of plaster of Paris and ceramic moulds.
- **Rajasthan** dominates with 81% of India's gypsum resources, while Jammu & Kashmir contributes 14%.
- The remaining 5% of resources are distributed across Tamil Nadu, Gujarat, Himachal Pradesh, Karnataka, Uttarakhand, Andhra Pradesh, and Madhya Pradesh. Rajasthan takes the lead as the largest producer of gypsum in India, followed by Tamil Nadu and Jammu & Kashmir.

Graphite

- Graphite displays an extraordinary resistance to heat and boasts high chemical inertness. It possesses the unique property of being the sole non-metal capable of conducting electricity.
- The carbon content within graphite is notably high, surpassing even that of anthracite coal, positioning it as a premium coal variety just superior to anthracite.
- The majority of graphite originates from formations occurring at convergent plate boundaries, where organic-rich shales and limestones underwent metamorphism due to the combined influence of elevated temperature and pressure.
- India produces both crystalline and amorphous variants of graphite. Additionally, synthetic graphite is synthesized in electric furnaces, utilizing anthracite as the primary raw material.
- Graphite mining operations, with the exception of a few underground mines, are typically characterized by small-scale open-cast mining.
- Notably, active graphite mining centers are situated in Palamu district (Jharkhand), Nuapada and Balangir districts (Odisha), as well as Madurai and Sivaganga districts (Tamil Nadu).

Diamonds

- Diamonds, renowned for their ornamental use and their role in polishing metallic surfaces and cutting gems, also have significant industrial applications.
- One crucial industrial use of diamonds is in the cutting edges of drills utilized for mineral exploration and mining.
- The primary diamond-bearing areas in India include the Panna belt in Madhya Pradesh and the Anantapur district in Andhra Pradesh.
- Recent discoveries have expanded to include the Raichur-Gulbarga belt in Karnataka, further enriching India's diamond reserves.

Atomic Minerals

- **Uranium, Plutonium, and Thorium** constitute the primary atomic minerals. Additionally, **beryllium, lithium, and zirconium** fall under this category. Zirconium is notably found along the Kerala coast and in alluvial rocks within Jharkhand's Ranchi and Hazaribagh districts. India possesses ample beryllium reserves to fulfill its atomic power generation requirements.
- **Plutonium**, though once naturally occurring, is now found only in trace quantities in the Earth's crust. It is primarily formed in nuclear power reactors through the neutron capture of uranium-238. The most common plutonium isotope produced in typical nuclear reactors is fissile Pu-239, serving as the primary fuel in fast neutron reactors.

Uranium

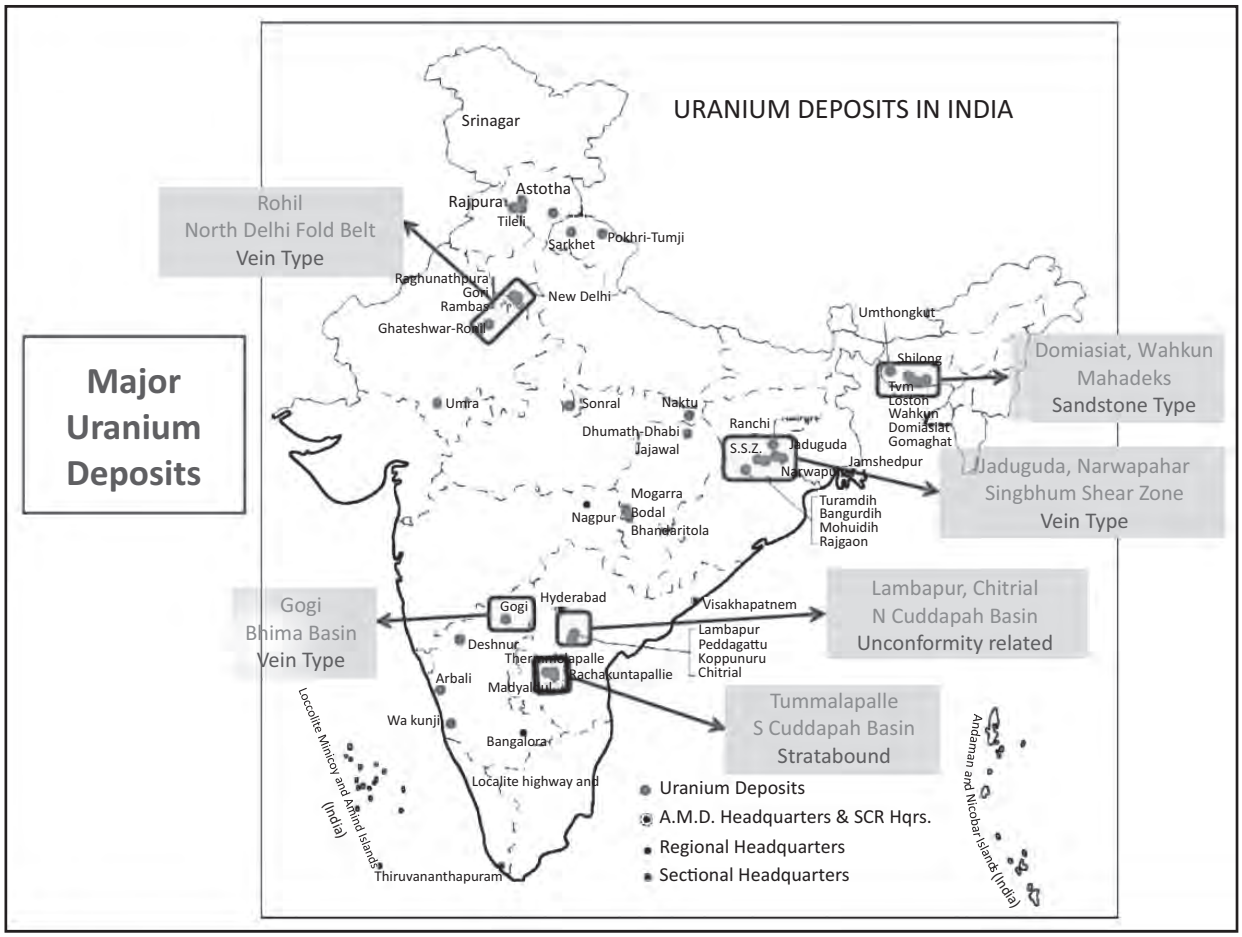


Fig. 3.40: Uranium Deposits in India

- **Uranium**, a silvery-grey radioactive chemical element, is naturally formed only during supernova explosions.
- It contributes to natural terrestrial radioactivity alongside thorium and potassium. With the chemical symbol U and atomic number 92, uranium's isotopes include 238U (99.27%) and 235U (0.72%).
- While all uranium isotopes are radioactive and fissionable, only 235U is fissile and capable of supporting a neutron-mediated chain reaction.
- Although traces of uranium are widespread, commercial extraction is feasible only in locations with a sufficient uranium proportion.
- Notable uranium mines include the Olympic Dam and the Ranger mine in Southern Australia, as well as high-grade deposits in the Athabasca Basin region of Canada, with the Chu-Sarysu basin in central Kazakhstan holding the majority of the country's uranium resources.

Uranium in India

- Uranium deposits in India are primarily found in sedimentary, volcanic, and metamorphic rocks.
- The major uranium-producing regions in India include:
  - **Singhbhum district, Jharkhand:** This region in eastern India is known for its significant uranium deposits, particularly in the Jaduguda, Bhatin, Narwapahar, and Turamdih mines.
  - **Tummalapalle, Andhra Pradesh:** Tummalapalle hosts one of the largest uranium reserves in the country, with extensive deposits of low-grade uranium ore.
- The exploration and mining of uranium in India are primarily carried out by the **Uranium Corporation of India Limited (UCIL),** a government-owned enterprise.
  - UCIL operates several uranium mines and processing facilities across the country.
- Uranium is primarily used as fuel in nuclear reactors for electricity generation. India's nuclear power program relies on domestically sourced uranium to fuel its reactors, supplemented by imports from other countries.
- The exploration, mining, and processing of uranium in India are regulated by various government agencies, including the **Department of Atomic Energy (DAE)** and the **Atomic Minerals Directorate for Exploration and Research (AMD)**, which is responsible for exploring and assessing uranium resources in the country.

Thorium

- Thorium, denoted by Th and with atomic number 90, is another naturally occurring radioactive element, along with uranium.

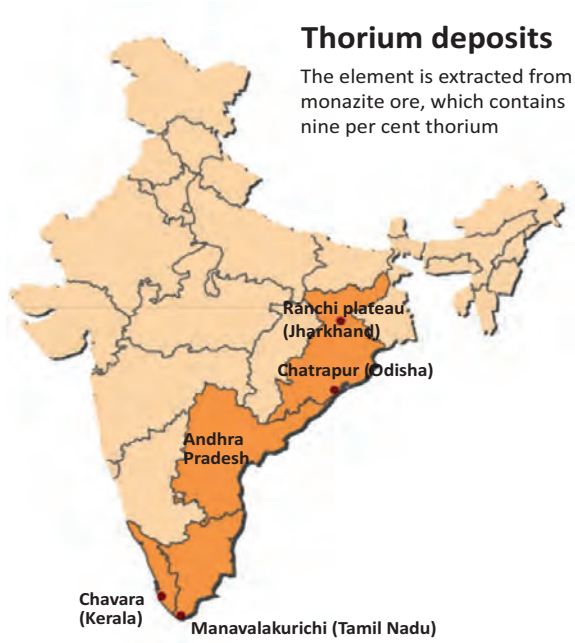


Fig. 3.41: Thorium Deposits in India

- Thorium is weakly radioactive, with all its known isotopes being unstable, including the seven naturally occurring ones: Thorium-227, 228, 229, 230, 231, 232, and 234.
- Thorium-232 stands as the most stable thorium isotope, representing almost all natural thorium, while the other five natural isotopes are found only in trace amounts.

Thorium Distribution in India

- Thorium is mainly obtained from monazite and ilmenite in the beach sands along the coast of Kerala and Tamil Nadu.
- World's richest monazite deposits occur in Palakkad and Kollam districts of Kerala, near Visakhapatnam in Andhra Pradesh and Mahanadi river delta in Odisha.
- Thorium, estimated to be three to four times more abundant than uranium in the Earth's crust, is primarily extracted from monazite sands, which contain 2.5% thorium and are scattered along the **Kerala coast**.
- Another thorium-bearing mineral is thorianite.
- Thorium holds promise as a potential replacement for uranium as nuclear fuel in reactors, although only a limited number of thorium reactors have been completed to date.
- India's known thorium reserves range from 457,000 to 508,000 tonnes and are primarily found in Kerala, Jharkhand, Bihar, Tamil Nadu, and Rajasthan.
- Notably, the United States, Australia, and India possess substantial thorium reserves.

Major Nuclear Reactors in India

A nuclear reactor is a device used to initiate and control a fission nuclear chain reaction or nuclear fusion reactions. Nuclear reactors are used at nuclear power plants for electricity generation and in nuclear marine propulsion.

- Presently, India has **22 operating reactors,** with an installed capacity of **6780 MWe**.
- Among these **18** reactors are **Pressurised Heavy Water Reactors (PHWRs)** and **4** are **Light Water Reactors (LWRs).**

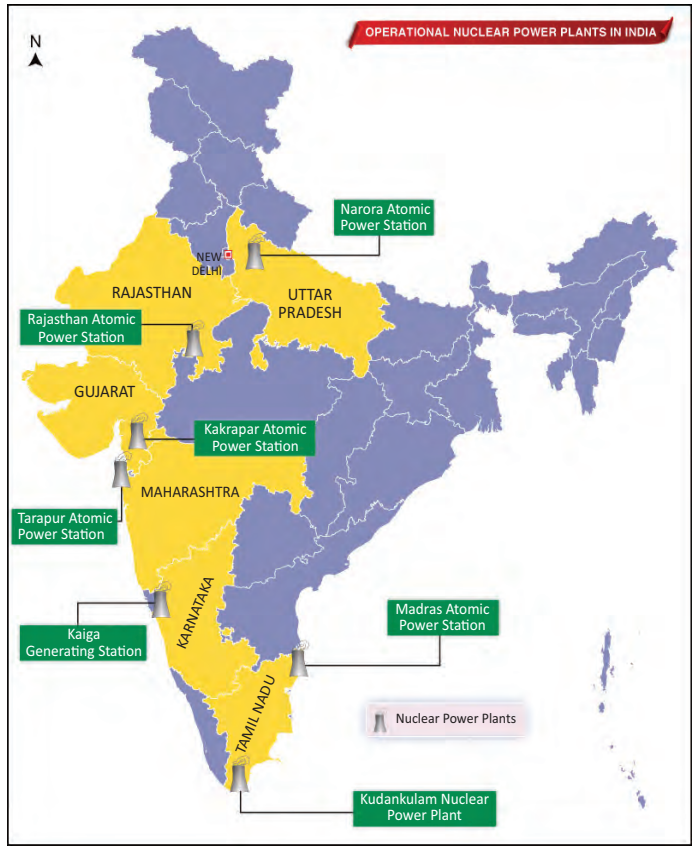


Fig. 3.42: Nuclear Power Plants in India

India's 3 Stage Nuclear Energy Programme			
Stage	**Objective**	**Technology**	**Fuel Cycle**
First Stage: PHWRs using Natural Uranium	Initial deployment of reactors using natural uranium and heavy water.	PHWR technology (developed indigenously).	Once-through cycle without reprocessing. Produces electricity and spent fuel.
Second Stage: FBRs using Plutonium	Production of fissile plutonium from non-fissile Uranium-238 through fast breeder reactors.	Fast breeder reactors.	Breeder fuel cycle: Plutonium reprocessing, mixed oxide (MO_x) fuel creation, achieving a closed fuel cycle.
Third Stage: Thorium Utilization in AHWRs	Utilization of Thorium-232 to breed fissile Uranium-233 for sustained nuclear power generation.	Advanced Heavy Water Reactors (AHWRs).	Thorium-uranium fuel cycle: Thorium neutron captures, Uranium-233 production, achieving self-sustaining cycle.

- India possesses significant reserves of uranium and thorium; however, challenges hinder their availability.
- Uranium mining encounters regulatory and environmental obstacles, leading to delays in exploration and extraction.
- India's thorium-based nuclear program remains in the research phase, facing challenges in achieving commercial-scale deployment of thorium-based reactors.

The escalating scarcity of fossil fuels has propelled a heightened reliance on nuclear energy globally, including India. The government aims to boost nuclear capacity to 22,480 MW by 2031-32, with multiple new nuclear power plants either under construction or in the planning stages.

Rare Earth Minerals

- Rare Earth Metals are a group of seventeen metallic elements, which encompass the fifteen lanthanides from the periodic table along with scandium and yttrium due to their similar physical and chemical properties to the lanthanides.

SEVENTEEN RARE EARTH ELEMENTS

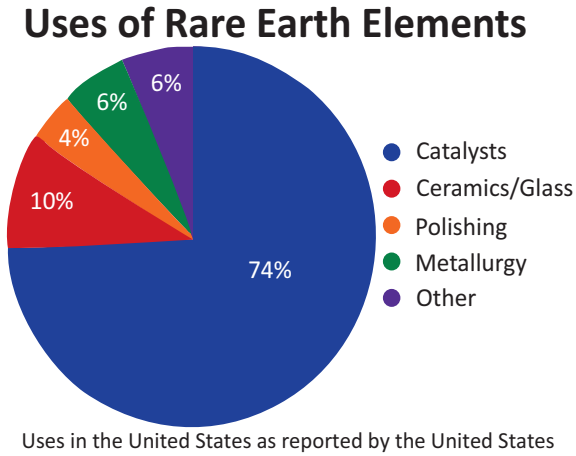
Rare earth name	Discovery year	Atomic name & number	Light/heavy REE	Critical/ Uncritical
Yttrium	1788	Y-39	Heavy	Critical
Cerium	1803	Ce-58	Light	Excessive
Lanthanum	1839	La-57	Light	Uncritical
Erbium	1842	Er-68	Heavy	Critical
Terbium	1843	Tb-65	Heavy	Critical
Ytterbium	1878	Yb-70	Heavy	Excessive
Holmium	1878	Ho-67	Heavy	Excessive
Scandium	1879	Sc-21	Heavy	Critical
Samarium	1879	Sm-62	Light	Uncritical
Thulium	1879	Tm-69	Heavy	Excessive
Praseodymium	1885	Pr-59	Light	Uncritical
Neodymium	1885	Nd-60	Light	Critical
Dysprosium	1886	Dy-66	Heavy	Critical
Europium	1886	Eu-63	Heavy	Critical
Gadolinium	1886	Gd-64	Heavy	Uncritical
Lutetium	1907	Lu-71	Heavy	Excessive
Promethium	1947	Pm-61		

Fig. 3.43: 17 Rare Earth Elements

- These **seventeen rare earths minerals** are cerium (Ce), dysprosium (Dy), erbium (Er), europium (Eu), gadolinium (Gd), holmium (Ho), lanthanum (La), lutetium (Lu), neodymium (Nd), praseodymium (Pr), promethium (Pm), samarium (Sm), scandium (Sc), terbium (Tb), thulium (Tm), ytterbium (Yb), and yttrium (Y).
- These elements are divided into two forms: **Heavy and Light Rare Earth Elements.**
- **Light rare earth elements (LREEs)** are abundantly available, while heavy rare earth elements (HREEs) are more critical due to their high demand and less availability.
  - Among LREEs, **Neodymium** is the most critical one as it is extensively used in all mobile phones, medical equipment and electric vehicles.
  - It is important for the manufacturing of permanent magnets that are used in wind turbines and data storage systems.
- **Heavy rare earth elements (HREEs)** like **dysprosium, yttrium and cerium** are critical for clean energy technologies, however, due to their limited supply, they have a small market.
- These elements possess unique magnetic, luminescent, and electrochemical properties, making them vital components in various modern technologies, including consumer electronics, computers, communication systems, healthcare, national defense, and clean energy technologies.
- They also play a crucial role in future technologies like high-temperature superconductivity and hydrogen storage for a post-hydrocarbon economy. While they can be found in various minerals, their concentrations are typically low, making economical extraction a complex process.

Significance of Rare Earth Minerals

- **Manufacturing of Batteries:** Minerals such as Cobalt, Nickel, and Lithium are essential components for manufacturing batteries used in electric vehicles.



Uses in the United States as reported by the United States Geological Survey Mineral Commodity Summary, 2021

Fig. 3.44: Major uses of rare earth elements

- **Consumer Products:** Rare Earth Elements (REEs) play a crucial role, albeit in small quantities, in over 200 consumer products. These products include mobile phones, computer hard drives, electric and hybrid vehicles, semiconductors, flat-screen TVs, monitors, and high-end electronics.
- **Electric Vehicles:** India has set ambitious goals for transitioning a significant portion of its transportation to electric vehicles (EVs). This transition will rely on minerals like Cobalt, Nickel, and Lithium.
- **Clean Energy:** These minerals are pivotal in the development of clean energy technologies, aligning with the pressing global need for sustainable energy solutions.

- **Industrial Use:** Traditional applications include the use of Cerium for glass polishing and lanthanum for car catalysts or optical lenses.
- **Manufacturing of Magnets:** Minerals like neodymium, praseodymium, and dysprosium are indispensable in magnet production, which finds applications in various industries and notably in wind turbines and drones.
  - **Example: More than 80 %** of the usage of rare earths in value terms is in RE permanent magnets which require Magnetic REE i.e. Neodymium, Praseodymium, Dysprosium and Terbium.

Global Distribution of Rare Earth Minerals

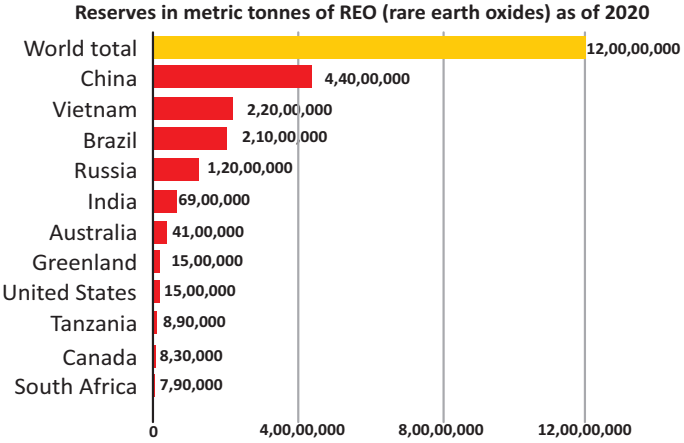


Fig. 3.45: Global Distribution of Rare Earth Reserves (in metric tonnes as of 2020)

- The global distribution of rare earth minerals is characterized by significant dominance by **China**, which holds the **largest reserves** and is the leading producer of these minerals.
- Other significant reserves are found in countries such as Australia, Russia, the United States, Brazil, India, and some African nations.
- Though **India has 6% of the world's rare earth reserves,** it only produces 1% of global output, and meets most of its requirements of such minerals from China. Efforts are being made to diversify rare earth production and reduce dependence on China by developing alternative sources and recycling technologies.

Chinese Dominance

- China has historically dominated the global rare earths market, at one point producing 90% of the world's rare earths.
- Today, China's share has decreased to around 60%, with other countries, including the Quad nations (Australia, India, Japan, and the United States), contributing to production.
- Following China's restriction of rare earth shipments in 2010 to Japan, the US, and Europe, production units emerged in Australia and the US, alongside smaller units in Asia, Africa, and Latin America.
- Despite these developments, China still maintains a dominant share in the processing of rare earths.

India's Rare Earth Scenario

The Rare Earth (RE) resources in India are reported to be the **fifth largest in the world** with estimated reserves of around **6.9 million tonnes.** The major rare earth minerals found in India include **monazite, xenotime, and bastnaesite.**

- **Monazite**: Monazite is a phosphate mineral and is the **most abundant rare earth mineral in India.**
  - It contains high concentrations of thorium and rare earth elements, making it a valuable resource.
  - Monazite is primarily found in the **coastal areas of Kerala, Tamil Nadu, and Andhra Pradesh.**
    - Due to its thorium content, monazite has significance in nuclear energy applications as part of the Third Stage of India's Nuclear Energy Programme.
- **Xenotime**: Xenotime is another important rare earth mineral found in India.
  - It contains yttrium and other rare earth elements.
  - Xenotime deposits are mainly found in the **beach sands of Kerala and Andhra Pradesh.**
    - Yttrium, along with other rare earth elements present in xenotime, has various industrial applications, including in **electronics, ceramics, and phosphors.**
- **Bastnaesite**: Bastnaesite is a rare earth fluorocarbonate mineral that contains cerium, lanthanum, and other rare earth elements.
  - Although not as abundant as monazite in India, bastnaesite deposits contribute to the country's rare earth resources.
  - Bastnaesite occurrences have been reported in regions such as **Tamil Nadu and Andhra Pradesh.**

Distribution of rare earth minerals in India

- Rare earth minerals in India are primarily found in the states of Kerala, Andhra Pradesh, Odisha, Tamil Nadu, and Rajasthan.

13.07 million tonnes in-situ **monazite** (containing ~55-60% total Rare Earth Elements oxide) resource occurs in the coastal beach placer sands in parts of Kerala, Tamil Nadu, Odisha, Andhra Pradesh, Maharashtra and Gujarat and in the inland placers in parts of Jharkhand, West Bengal and Tamil Nadu.

*{**Placers** are deposits of sand or gravel in the bed of a river or lake, containing particles of valuable minerals}*

Exports and Imports

India has been focusing on the exploration and extraction of rare earth minerals to reduce dependence on imports and strengthen its position in the global rare earth market. Efforts are being made to develop technologies for the processing and separation of rare earth elements from their ores to support various industries such as electronics, renewable energy, and defense.

Exports	Imports
In 2021, India exported $56.9M in Rare-Earth Metal Compounds, making it the **7th largest exporter** of Rare-Earth Metal Compounds in the world.	In 2021, India imported $11.5M in Rare-Earth Metal Compounds, becoming the **19th largest importer of Rare-Earth Metal Compounds in the world.**
The main destination of Rare-Earth Metal Compounds exports from India are: **Japan** ($20M), **Vietnam** ($15.6M), **Germany** ($6.82M), **China** ($4.17M), and **France** ($3.52M).	India imports Rare-Earth Metal Compounds primarily from: **China** ($4.33M), **South Korea** ($3.03M), **Japan** ($1.67M), **Germany** ($887k), and **United States** ($531k).
The **fastest growing export markets** for Rare-Earth Metal Compounds of India between 2020 and 2021 were **Vietnam** ($14.9M), **Japan** ($6.74M), and **Germany** ($6.66M).	The **fastest growing import markets** in Rare-Earth Metal Compounds for India between 2020 and 2021 were **China** ($2.05M), **Germany** ($737k), and United States ($362k).

India's Policy

- India's current policy on rare earths involves exploration conducted by the **Bureau of Mines and the Department of Atomic Energy.**
- Mining and processing activities were previously carried out by minor private players, but they are now concentrated in the hands of **IREL (India) Limited,** a Public Sector Undertaking under the **Department of Atomic Energy**.

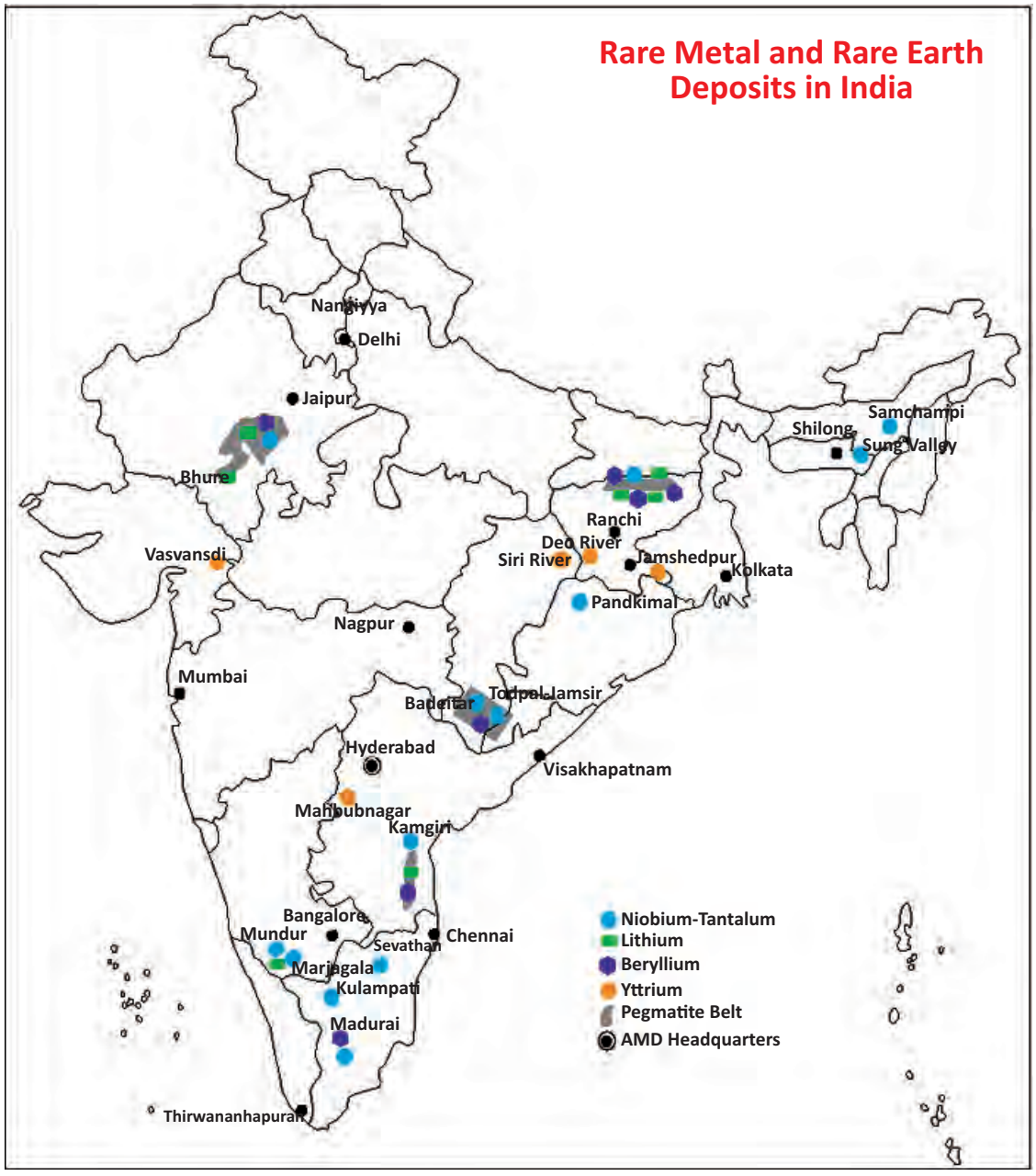


Fig. 3.46: Distribution of rare earth minerals in India

- India has granted government corporations like IREL a monopoly over the primary mineral containing rare earth elements, monazite beach sand, which is found in various coastal states.
- IREL focuses on producing rare earth oxides through cost-effective upstream processes and sells them to foreign firms for downstream processes, which are high-cost and high-reward, involving the extraction of metals and the manufacturing of end products.
- Additionally, IREL is dedicated to providing thorium, extracted from monazite, to the Department of Atomic Energy.

Way Forward

- The Confederation of Indian Industry (CII) has proposed the establishment of an 'India Rare Earths Mission' staffed by professionals, similar to the successful India Semiconductor Mission.
  - This initiative is seen as a crucial component of the Deep Ocean Mission.
- Additionally, CII recommends integrating rare earth minerals into the 'Make In India' campaign, drawing inspiration from China's 'Made in China 2025' initiative.
  - The latter prioritizes new materials, including permanent magnets produced using rare earth minerals.
- India should actively engage in multinational forums or leverage existing partnerships like QUAD and BIMSTEC to facilitate discussions on securing critical mineral supply chains.
  - It is imperative for the government to engage in high-level decision-making to formulate strategies for establishing vertically integrated supply chains in the manufacturing of green technologies.
- To streamline and regulate activities in the rare earths sector, India should consider establishing a new regulatory body, the **Department for Rare Earths (DRE)**, which can serve as both a regulator and facilitator for businesses operating in this domain.
- Securing self-sufficiency in rare earths is crucial for India due to their strategic role in advanced technologies. With substantial monazite reserves, fostering a robust domestic industry is vital to reduce dependence on imports, especially from major global suppliers like China.
- A self-reliant rare earth supply chain is essential for India's developmental goals, national security, and contributions to global initiatives like climate change mitigation. Prioritizing investments in exploration, processing technologies, and regulatory frameworks is imperative for capitalizing on India's rare earth potential and building a resilient industry.

Mining Sector in India

- The mining sector in India plays a crucial role in the country's economy, contributing significantly to GDP, employment generation, and the production of essential raw materials for various industries.
- India produces as many as 95 minerals, which include 4 fuel, 10 metallic, 23 non-metallic, 3 atomic and 55 minor minerals (including building and other materials).

- India is the largest sponge iron (DRI) producer.
- India is currently the 2nd largest crude steel and coal producer in the world.
- India is the 4th largest iron ore producer in the World.

Role of Mining in Indian Economy

- India's economy is set to grow around 7%, with infrastructure and automobiles gaining momentum, increasing the demand for power and steel.
- Mining supplies raw materials to these sectors, with a total mineral production value of $16.6 billion in 2017-18, up by 13% from the previous year.
- The mining sector contributes 2.3-2.5% to the GDP and saw a 5.72% CAGR in mineral production between 2013-14 and 2017-18. The labour-intensive sector offers employment for unskilled and skilled workers, fostering overall regional development and associated industries.

Legislative Framework of Mining Sector

- The Indian Constitution assigns states the ownership of minerals within their boundaries (List II, serial No. 23), while minerals within the exclusive economic zone (EEZ) fall under central government ownership (List I, serial No. 54).
- The **Mines & Minerals (Development and Regulation) (MMDR) Act of 1957** was enacted to manage mineral resources. The **MMDR Amendment Act of 2015** introduced auctions for mineral concessions, established the District Mineral Foundation (DMF) for affected communities and created the National Mineral Exploration Trust (NMET) to boost exploration. It also implemented measures against illegal mining.

District Mineral Foundation (DMF)

DMF was established under the Mines and Minerals (Development and Regulation) Amendment Act, 2015, with the objective of addressing the socio-economic and developmental needs of all districts affected by mining-related activities.

- Section 9(B) of the MMDR Act provides for the establishment of DMF as a non-profit body, object of DMF, and vests power in the State Government to prescribe the composition and functions of District Mineral Foundation.

- So far, DMFs have been set up in **626 districts in 23 States** in the country which have framed DMF rules.

Salient features

- **Objective**: To work for the interest and benefit of persons, and areas affected by mining related operations in such manner as may be prescribed by the State Government.
- **Funding**: DMF is funded through contributions from mining companies, which are required to allocate a portion of their revenue for the benefit of affected communities.
- **Utilization of Funds:** DMF funds are utilized for various development projects and initiatives in areas such as healthcare, education, drinking water supply, sanitation, and infrastructure development.

National Mineral Exploration Trust (NMET)

NMET was established under the Mines and Minerals (Development and Regulation) Amendment Act, 2015, to promote mineral exploration activities in India and reduce the country's dependence on mineral imports.

Salient features:

- **Funding**: NMET is funded through contributions from mining companies, which are required to allocate a percentage of their royalty payments to the trust.
- **Objectives**: The primary objective of NMET is to provide financial support for mineral exploration activities, including geological mapping, geophysical surveys, and drilling operations, to identify new mineral resources and increase the mineral potential of the country.
- **Allocation of Funds:** NMET funds are allocated for mineral exploration projects undertaken by government agencies, private companies, and academic institutions, with a focus on priority areas identified by the government.

- India, as a party to the UN treaty, has exclusive rights to explore polymetallic nodules in the Central Indian Ocean Basin, regulated by the **International Seabed Authority (ISA)**.

The International Seabed Authority (ISA)

The International Seabed Authority (ISA) is an intergovernmental organization established under the United Nations Convention on the Law of the Sea (UNCLOS).

- **Purpose**: The ISA is tasked with regulating activities related to mineral resources exploration and exploitation in the international seabed area beyond national jurisdiction, known as the "Area."
- **Legal Framework:** The ISA operates under UNCLOS, which provides the legal framework for the conservation and sustainable use of ocean resources. It specifically governs the exploration and exploitation of mineral resources in the Area.
- **Membership**: The ISA has 168 member states and the European Union. It provides a forum for member states to collaborate on matters related to deep-sea mining and ensures that activities in the Area are conducted for the benefit of humankind as a whole.
- **Functions**:
  - Issuing exploration and exploitation licenses to qualified entities.
  - Establishing rules and regulations for deep-sea mining activities, including environmental protection standards and royalty regimes.
  - Facilitating the transfer of marine technology and promoting capacity-building initiatives in developing countries.
  - Conducting scientific research and assessments to better understand the marine environment and its resources.
- **Organs**: The ISA consists of various organs, including the Assembly, the Council, and specialized committees, which oversee different aspects of the organization's work.

Challenges Faced by the Mining Sector in India

Although India is situated within Gondwanaland, its mining industry makes a significantly smaller contribution to its Gross Domestic Product (GDP), approximately 2.5%. The reasons for it are:

- **Displacement and Rehabilitation Issues:** Large-scale displacement and inadequate rehabilitation measures alienate and erode trust among local communities. Protests against mining projects have occurred in various regions like Niyamgiri Hills, Odisha, and Sterlite in Tamil Nadu.
- **Safety Issue:** Miners are exposed to risk due to rudimentary methods and lack of safety protocols, resulting in accidents and human rights violations.
- **Rat Hole Mining:** Illegal mining, mainly in northeastern areas like Meghalaya, involves small tunnels, banned by the NGT in 2015 for being unsafe and unscientific. Thin coal seams in Meghalaya make traditional methods economically unviable, leading to the use of rat hole mining.
- **Environmental/Health Issues:** Mining activities in Rajasthan, Karnataka, and coal mining in Damodar River have caused environmental pollution. Biodiversity loss and damage to local heritage result from mining. Miners and locals suffer from diseases like fibrosis, pneumoconiosis, and silicosis. Water and air pollution, such as acidic rivers and contaminated air, are prevalent in mining areas.
- **Administrative Issues:** Arbitrary coal mine allocations result in litigation, cancellations, and corruption allegations. Bureaucratic delays in environmental clearances hinder mining operations. Judicial interventions lead to delays and financial losses for

investors, as seen in Andhra Pradesh, Telangana, Karnataka, Odisha, and Goa.

- **Illegal Mining:** Illegal Mining practice often includes violations of environmental, labour, and safety standards. In regions like Odisha, some mining companies engage in activities such as under-reporting the quantity of minerals extracted and transported, while also evading rightful royalties and taxes.
- **Infrastructure bottlenecks**: These hinder the sector's growth potential, particularly due to inadequate **transportation** infrastructure.
- **Quality of ores**: India possesses abundant reserves; however, the quality of certain resources such as coal may not always meet standards, leading to the necessity of imports.

Government Initiatives

- **Star rating of mining leases** promotes sustainable development in the sector. The best performers amongst the five-star rated mines are felicitated every year by the Hon'ble Minister of Mines in a national-level conclave organized by the Ministry of Mines.
- MoU between IBM and NRSC, ISRO, for monitoring mining activities using **satellite imagery.**
- The **Mining Surveillance System (MSS)** uses remote sensing technology to combat illegal mining.
- The **District Mineral Foundation Fund (DMF)** supports mining-affected communities through PMKKKY.
- The **National Mineral Exploration Policy** attracts private exploration agencies.
- **100% FDI** is permitted for mining and exploration, promoting the sector's growth.

Mines and Minerals (Development and Regulation) Amendment Act, 2015

The Mines and Minerals (Development and Regulation) Amendment Act, 2015, was enacted to bring significant changes to the regulatory framework governing the mining sector in India.

Salient Features:

- **Auction of Mineral Resources:** The amendment introduced a transparent auction process for the allocation of mineral resources, including coal, lignite, and other non-coal minerals. This aimed to promote fair competition, efficiency, and transparency in the allocation of mining leases.
- **Revenue Sharing:** The MMDR Amendment 2015 mandated revenue sharing for all mining leases, ensuring that a percentage of the revenue generated from mining activities is shared with the government. This revenue-sharing mechanism aimed to enhance government revenue and ensure equitable distribution of benefits from mineral extraction.
- **Compensation and Rehabilitation:** The amendment strengthened provisions related to compensation and rehabilitation for individuals and communities affected by mining activities. It emphasized the importance of sustainable development and the well-being of affected communities.
- **Renewal of Mining Leases:** The MMDR Amendment 2015 introduced provisions for the automatic renewal of mining leases, subject to compliance with specified conditions. This aimed to provide certainty and stability to mining operations and investors.
- **Transparency and Accountability:** The amendment enhanced transparency and accountability in the mining sector by introducing provisions for online auctions, electronic monitoring of mining activities, and stricter penalties for violations of mining laws and regulations.

Recent initiatives in Mining Sector in India

- Launch of first ever auction process for Critical and Strategic Minerals for India
- **Mines and Minerals (Development & Regulations) Amendment Act, 2023: The Mines and Minerals (Development and Regulation) Act, 1957** has been amended through Mines and Minerals (Development and Regulation) Amendment Act, 2023.

Salient Features of Mines and Minerals (Development & Regulations) Amendment Act, 2023

- **Introduction of exploration licence for deep-seated and critical minerals:** The exploration licence granted through auction shall permit the licencee to undertake reconnaissance and prospecting operations for **critical and deep-seated minerals** mentioned in the **newly created Seventh Schedule to the Act.**
- **Delisting of minerals from the list of atomic minerals: 6 minerals,** namely:
  - (i) Beryl and other beryllium-bearing minerals
  - (ii) Lithium-bearing minerals,
  - (iii) Niobium-bearing minerals,
  - (iv) Titanium bearing minerals and ores,
  - (v) Tantallium-bearing minerals and
  - (vi) Zirconium-bearing minerals and ores, have been **delisted from the list of atomic minerals** specified in Part-B of the First Schedule to the Act.

  This has opened private sector participation in the mining of these minerals having various applications in space industry, electronics, communications, energy sector, electric batteries and are critical in net-zero emission commitment of India.
- **The Offshore Area Minerals (Development And Regulations) Amendment Act, 2023**
- Streamlining of rules /provisions of District Mineral Foundation (DMF) for more effective implementation of **Pradhan Mantri Khanij Kshetra Kalyan Yojana (PMKKKY)**

Pradhan Mantri Khanij Kshetra Kalyan Yojana (PMKKKY)

Pradhan Mantri Khanij Kshetra Kalyan Yojana (PMKKKY) is a welfare scheme launched by the Government of India aimed at the welfare and development of areas and communities affected by mining-related activities.

Salient Features:

- **Framework**: PMKKKY provides a framework for the utilization of funds collected under District Mineral Foundation (DMF), which is established in mining-affected districts.
- **Funding**: The scheme utilizes funds collected through contributions from mining companies, which are mandated to allocate a portion of their revenue for the DMF.
- **Focus Areas:** PMKKKY focuses on five key areas for the welfare and development of affected communities, including **healthcare, education, drinking water supply, sanitation, and infrastructure development.**
- **Implementation**: PMKKKY is implemented at the district level through the District Mineral Foundation Trust, which oversees the planning and execution of development projects in consultation with local stakeholders and government authorities.

- Stepped up exploration activities by Geological Survey of India (GSI) for strategic and critical minerals and also fertilizer minerals
- **Further strengthening of bilateral and multilateral cooperation in mining sector:** MoUs were signed with **Peru,Mozambique and Bolivia** for cooperation in the field of Mineral Resources
- Successful participation and **setting up of Mines Pavilion** for the first time at **India International Trade Fair (IITF- 2023)**.

Case Study (India): Singareni Collieries Company Limited (SCCL)

- SCCL is a state-owned coal mining company in India, operating in the southern part of the country.
- It has been recognized for its efforts in adopting advanced mining technologies and practices to enhance efficiency and safety.
- SCCL has implemented initiatives for environmental sustainability and community development in the regions where it operates.

Case Study (World): Escondida Copper Mine, Chile

- The Escondida mine, located in the Atacama Desert of Chile, is the world's largest copper mine.
- It is operated by BHP and is renowned for its scale, technological innovation, and efficient mining processes.
- The mine has implemented water management strategies to address water scarcity in the desert region and has initiatives focused on community development and environmental stewardship.

Mining In Aravallis

Illegal Mining: Illegal mining encompasses any mining operation conducted without proper state authorization, often lacking essential permits, licenses, or land rights. Examples include artisanal mining (Artisanal and small-scale mining (ASM) represents an predominantly informal economic sector comprising individuals worldwide who employ rudimentary tools to extract a wide range of resources from the Earth) is one form of illegal mining, while it can also serve as a means of subsistence. In some cases, large-scale organized crime groups drive illegal mining syndicates. Approximately 80% of small-scale mining operations worldwide can be classified as illegal.

Aravalli Bachao Citizens Movement

- **About:** The Aravalli Bachao Citizens Movement consists of citizens from various regions across India, including the National Capital Region. This non-partisan group is devoid of any political, religious, or corporate affiliations.
- **Mission:** The primary objective of this citizen-led movement is to safeguard the Aravalli region from various threats, including mining, real estate development, illegal encroachments, weakening protective laws, toxic landfills, and waste-to-energy plants.
- **Demand:** The movement strongly advocates for the recognition of the entire 700 km Aravalli range as a living ecosystem and its designation as a permanent biosphere reserve. This designation would protect the region, serving as a climate regulator, desertification barrier, vital water recharge area, biodiversity hotspot, and wildlife corridor, preserving it for future generations.

Locations of Illegal Mining

- The presence of illegal mining activities was identified in multiple areas, including Pandala Hills near Gairatpur Bas village, Aravalli area near Tikli village, Tauru police station in Tauru Block, Palla village in Nuh Block, and Baghola village in Ferozepur Jhirka block.

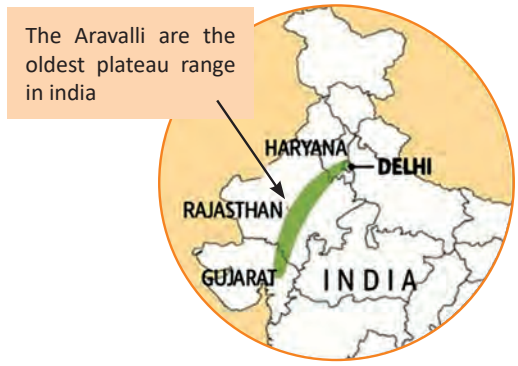


Fig. 3.47: Location of Aravalli Range

Committee Formation

- **Formation:** An eight-member committee was established on July 7,2023 chaired by the Chief Conservator of Forests of the Forest Department, Haryana. It included a representative from the Ministry of Environment, Forest and Climate Change, mining officials, and a senior police officer.

- **Purpose:** The committee conducted on-site visits to all 16 locations to assess the extent of illegal mining and its resulting environmental degradation.
- **Documentation:** The committee's report incorporated drone imagery of the excavation sites and satellite images captured at various time points for comprehensive evaluation.

National Mineral Policy, 2019

- The National Mineral Policy 2019 seeks to enhance the regulation of the mining sector for improved and sustainable development. It also strives to ensure transparent and equitable enforcement, with a particular focus on addressing the concerns of people, especially those residing in tribal areas, who are affected by mining projects.
- The impetus for reviewing and amending the Mineral Policy originated from a directive by the Supreme Court in the **Common Cause versus Union of India case.** In adherence to the Supreme Court's order, a committee was established, chaired by Dr. K. Rajeswara Rao, to undertake the necessary review and changes.

Highlights Of The Policy

- **Right to First Refusal:** Firms with reconnaissance permits (RPs) will have the right of first refusal for mining in areas where they find mineral evidence, eliminating the need for government auctions.
- **Reserved Area Rationalization:** Underutilized areas earmarked for public sector units (PSUs) will be auctioned, aligning with NMP 2019.
- **Taxation Harmonization:** The policy emphasizes aligning India's tax, levy, and royalty rates with global benchmarks to attract increased private sector participation.
- **Transportation Focus:** NMP 2019 promotes coastal waterways and inland shipping for mineral transportation and encourages dedicated mineral corridors.
- **Export-Import Policy:** A long-term export-import policy is proposed to incentivize large-scale commercial mining.
- **Inter-Generational Equity:** The policy introduces the concept of Intergenerational Equity, focusing on the well-being of present and future generations. It proposes an inter-ministerial body for sustainable development.
- **Regulation Improvements:** E-Governance, IT-enabled systems, and awareness campaigns will enhance mineral sector regulation.

Significance Of The Policy

- **Effective Regulation:** The policy aims to bring transparency and efficiency to the mining sector through improved regulation.
- **Addressing Affected Persons:** Utilizing the district mineral fund will aid equitable development for project-affected individuals, particularly those in tribal areas.
- **Private Sector Engagement:** Encouraging private sector participation in the mining industry aligns with the **"Make in India"** initiative.
- **Timely Clearances:** An online public portal with delay triggers for clearances has been established.
- **Industry Status:** Granting industry status to mining activities enhances financing for the private sector and promotes acquisitions of mineral assets abroad, strengthening the mining sector.

Critical Minerals for India

- Critical minerals are a set of naturally occurring elements and compounds that are deemed essential for the economic well-being of a country and are considered crucial for the functioning of various industries, national security, and the advancement of technology.
- The term "critical minerals" is often used to highlight the strategic importance of these resources due to their irreplaceable role in key sectors such as manufacturing, defense, energy, and technology.
- Critical minerals are essential for a nation's economic development and security. A shortage or over-concentration of their extraction and processing can lead to vulnerabilities in the supply chain, potentially causing supply disruptions.
- The declaration of critical minerals is a dynamic process that can change over time due to evolving technologies, market dynamics, and geopolitical considerations.
- Different countries have their unique lists of critical minerals based on their specific circumstances and priorities. For example, the US has identified 50 critical minerals, Japan (31), the UK (18), the EU (34), and Canada (31).
- In the case of India, an **Expert Committee under the Ministry of Mines** has identified 30 critical minerals, including Antimony, Beryllium, Bismuth, Cobalt, Copper, Gallium, Germanium, Graphite, Hafnium, Indium, Lithium, Molybdenum, Niobium, Nickel, Platinum Group Elements (PGE), Phosphorus, Potash, Rare Earth Elements (REE), Rhenium, Silicon, Strontium, Tantalum, Tellurium, Tin, Titanium, Tungsten, Vanadium, Zirconium, Selenium, and Cadmium.
- Additionally, there is a recommendation to establish a **Center of Excellence for Critical Minerals (CECM)** within the Ministry of Mines, which would periodically update the list and notify India's critical mineral strategy.

Significance Of Critical Minerals

- **Economic Development:** Industries like high-tech electronics, telecommunications, transportation, and defence rely heavily on these minerals. Furthermore, they are crucial for green technologies like solar panels, wind turbines, batteries, and electric vehicles. Given India's significant domestic demand in these sectors,

their growth can lead to job creation, income generation, and innovation.

- **National Security:** These minerals are vital for defence, aerospace, nuclear, and space applications, where high-quality and reliable materials capable of withstanding extreme conditions are essential. Securing a steady supply of critical minerals is necessary for defence preparedness and self-reliance.
- **Environmental Sustainability:** Critical minerals are integral to the transition toward clean energy and a low-carbon economy, reducing India's reliance on fossil fuels and greenhouse gas emissions. With India's commitment to achieving 450 GW of renewable energy capacity by 2030, these minerals play a crucial role in meeting its green objectives.
- **International Cooperation:** Collaborations with other countries enable India to diversify its sources of import, reduce dependency on China, and enhance mineral security and resilience.

Challenges Related To Critical Minerals

- **Implications of the Global Conflict:** Russia is a significant producer of various critical minerals, and Ukraine possesses reserves of lithium, cobalt, graphite, and rare earth elements. The ongoing conflict between the two countries can disrupt critical mineral supply chains.
- **Limited Domestic Reserves:** India has limited reserves of critical minerals like lithium, cobalt, and rare earth elements, relying heavily on imports. This dependency on other nations for supply can leave India vulnerable to price fluctuations, geopolitical factors, and supply disruptions.
- **Increasing Demand:** The manufacturing of renewable energy technologies and the shift to electric vehicles require substantial quantities of minerals such as copper, manganese, zinc, lithium, cobalt, and rare earth elements. India's limited reserves and growing demand necessitate reliance on foreign partners to meet domestic needs.

CONCLUSION

The mining sector in India is a vital pillar of the economy, serving as a backbone for industrial growth, employment generation, and economic development.

As India progresses towards sustainable development, it is imperative to address the challenges associated with the mining sector, including environmental degradation, land acquisition issues, and social conflicts.

Embracing responsible mining practices, promoting transparency and accountability, and ensuring equitable distribution of benefits are crucial steps towards achieving sustainable development goals while maximizing the sector's potential to contribute to India's growth target of becoming a '$5 trillion economy' and further the 3rd largest economy in the world.

Energy Resources

4

INTRODUCTION

The chapter looks into **conventional and non-conventional energy sources,** discussing their economic, environmental and geopolitical implications. It focuses on the sustainability issues posed by traditional energy sources such as oil, gas, coal, and nuclear power, as well as the promise of renewable energy sources such as solar, wind, biomass, geothermal, and ocean energy to support long-term growth. It also investigates the energy crisis, assigning its causation to issues such as resource depletion, geopolitical tensions, and rising demand, and considers the severe economic and societal consequences that follow. To address current and future energy concerns, the chapter recommends a multimodal approach that includes diversifying energy sources, increasing efficiency, encouraging technical innovation, and bringing energy sector reforms.

ENERGY RESOURCES

Energy resources are the sources of energy used to generate **heat, light, and power.** These resources are essentially divided into two categories: **conventional and non-conventional.**

CLASSIFICATION OF ENERGY RESOURCES

Energy resources are critical to powering our world and are classified into conventional and non-conventional resources.

Conventional resources, such as **fossil fuels** (coal, oil, and natural gas) and **nuclear energy,** have long served as the foundation of global energy production. However, their **environmental impact** and finite nature present substantial concerns.

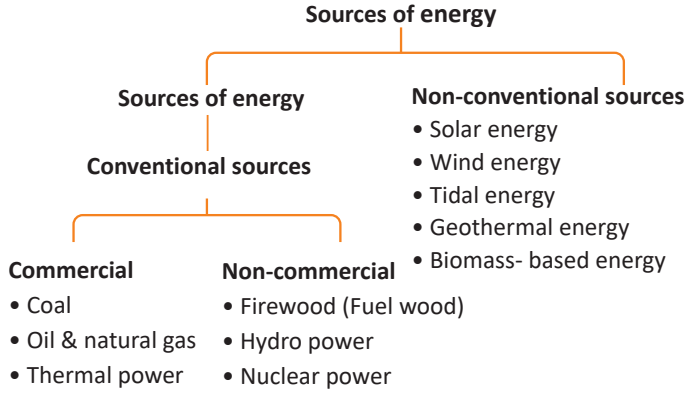


Fig. 4.1: Sources of Energy

- **Non-conventional energy** sources, such as **solar, wind, hydropower, geothermal,** and **biomass,** are gaining popularity due to their **sustainability** and **low environmental impact.**
- The balance between these resources is altering as the globe prioritises **sustainable energy** solutions, resulting in a future in which non-conventional sources play a larger role.

IGNITE YOUR MIND

Your phone, laptop, even your fridge – they all silently need energy. Can you become an energy detective and identify hidden energy drains in your daily life?

GENERAL TRENDS OF ENERGY PRODUCTION AND CONSUMPTION

The global production of conventional energy, principally consisting of **fossil fuels and nuclear power,** continues to play a vital role in supplying the world's energy needs.

- **Investment Trends**
  - The **International Energy Agency (IEA)** predicted an investment of around **USD 2.8 trillion** in the energy sector in 2023.
  - While a large share, more than **USD 1.7 trillion,** is devoted to **clean energy,** investments in **conventional energy** sources remain significant.
- **Energy Intensity**
  - Global energy intensity improved somewhat in 2022, **dropping by 1.2%.**
  - This suggests a **gradual but continual shift** in the energy mix, yet traditional sources such as fossil fuels continue to **dominate.**
- **Electricity Generation**
  - Global power generation increased by **2.3% in 2022.**
  - Notably, renewable sources such as **wind and solar** now account for a **record 12% of worldwide electricity generation,** demonstrating a trend towards cleaner energy.

Although there is a shift towards renewable energy sources, fossil fuels still play a significant role in global energy production. The move to cleaner energy sources is ongoing, but conventional energy remains an essential component of the existing global energy framework.

PRIMARY GLOBAL ENERGY CONSUMPTION 2022

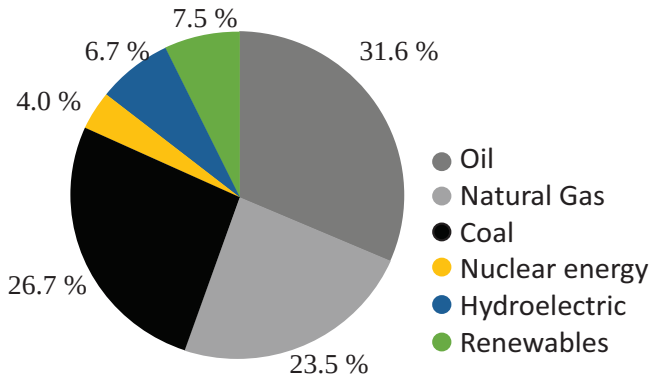


Fig. 4.2: Primary Global Energy Consumption 2022

AN OVERVIEW OF THE INDIAN ENERGY PARADIGM

The **International Energy Agency's "India 2020 Energy Policy Review"** presents a detailed review of India's energy industry, outlining its current situation, problems, and ongoing moves towards a more sustainable energy paradigm.

- **Import Dependence**
  - India is heavily dependent on imports for its energy needs, particularly oil and gas. The country imports over 80% of its crude oil requirements and a significant portion of its natural gas consumption
  - This high level of import dependence places India in a vulnerable position regarding energy security and exposes the economy to global oil price fluctuations.
- **Ongoing Shift Towards Renewable Energy**
  - Recognising the challenges of import dependence and the need for sustainable development, India is undergoing a significant shift towards renewable energy.
  - The government has set ambitious targets to **increase the share of renewables** in its energy mix.
  - Initiatives like the **National Solar Mission and the National Wind Energy Mission** aim to promote solar and wind energy, respectively. India's renewable energy capacity has seen rapid growth, making it one of the world's largest markets for renewable energy investments.
- **Energy Efficiency Measures**
  - India has also focused on improving energy efficiency across various sectors to reduce **overall energy consumption** and mitigate the environmental impact of its energy use.
  - Programmes like the **Perform, Achieve, and Trade (PAT)** scheme for industrial energy efficiency and the **UJALA scheme** for LED bulb distribution are examples of efforts to enhance energy efficiency.
- **Electrification and Access to Energy**
  - The government has made significant strides in increasing access to electricity through schemes like the **Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya),** aiming for universal household electrification.
  - This initiative has substantially reduced the number of households without electricity access, contributing to social and economic development.
- **Challenges and Policy Responses**
  - Despite progress, India faces challenges such as **ensuring energy access for all**, managing the environmental impact of energy production and use, and reducing dependence on energy imports.
  - The government's response includes policy reforms, investment in energy infrastructure, and international collaborations to secure energy supplies and promote the adoption of clean energy technologies.
- **Way Forward**
  - The way forward for India's energy sector involves continuing to diversify energy sources, with a significant focus on renewables, enhancing energy efficiency, and strengthening energy security through strategic partnerships and domestic resource development.
  - The transition to a low-carbon economy is also a critical component of India's energy strategy, aligning with global efforts to combat climate change.

RESERVES AND SOURCES OF ENERGY

These are quantities of energy sources that are known to exist and are recoverable under **current economic and operational conditions.**

- Energy reserves and sources are the **foundation** of global energy system, which includes a wide range of materials and technologies used to power society and economies.
- At the centre of this system are **energy reserves,** which are essentially **stockpiles of natural resources** that can be used to generate energy.
- These reserves include fossil fuels such as coal, oil, and natural gas, which have traditionally been the primary sources of global energy supply, as well as **uranium,** which is required for nuclear power generation.
- The panorama of energy sources is **vast and diverse,** expanding beyond conventional reserves.
- It covers renewable energy sources such as solar, wind, hydropower, geothermal, and biomass.
- Due to the urgent need to switch to **more environmentally friendly** and sustainable energy sources, renewables are becoming increasingly significant in the global energy mix.

This complete energy framework, with its mix of old and developing sources, lays the groundwork for a more in-depth look at specific energy types, such as coal, which plays a distinct role and faces unique challenges in the global energy narrative.

CONVENTIONAL SOURCES OF ENERGY

Conventional energy sources, predominantly fossil fuels such as **coal, oil, and natural gas,** have historically powered the world due to their availability and well-established extraction and consumption infrastructure. Despite their effectiveness in satisfying global energy demands, these sources represent substantial environmental and safety risks, such as pollution and the disposal of nuclear waste, forcing a shift towards renewable energy.

IGNITE YOUR MIND

Fuel for Thought: Why are some countries chained to specific energy sources like coal or oil? Is it a historical hangover, a geographical curse, or an economic labyrinth? Decode the hidden messages woven into their energy choices.

Coal

- Coal, also known as **"black gold,"** is typically found in sedimentary layers. Its constituents include **carbon, volatile matter, moisture, and ash,** with trace amounts of **sulphur and phosphorus.**
- The majority of the world's coal resources were formed during the **Carboniferous period,** which lasted from around **350 million ago to 299 million years ago** and is known for its **high-quality coal reserves,** hence the name **"Carboniferous,"** referring to coal-bearing strata.
- These coal deposits formed over many years, when the Earth was covered in enormous, **swampy forests.**
- The compression, combined with heat, caused chemical and physical changes within the plant layers, expelling oxygen and forming carbon-rich deposits.
- Eventually, this biological stuff turned into coal.

Relationship Between Age and Carbon Content

The energy yield of coal is determined by its carbon content, with older coal having larger carbon percentages.

This correlation is due to the time and degree of heat and pressure applied to the wood.

Deeper burial generates greater pressure and heat, increasing the carbon concentration.

Meanwhile, as time passes, the amounts of oxygen, nitrogen, and moisture in the coal fall while the fraction of carbon grows.

It is worth emphasising that the total amount of carbon does not grow; rather, its proportion rises as the abundance of other elements decreases.

Stages of Coal Formation

- The creation of coal, known as **coalification,** occurs in several stages.
- Initially, buried plant debris transforms into **peat,** the earliest step of coal formation.
- Peat undergoes dramatic changes throughout time, eventually becoming **lignite.**
- Further modifications occur, transforming lignite into **subbituminous coal.**
- **Sub-bituminous coal** then undergoes additional modifications to become **bituminous coal,** which stands out for having a higher carbon content.
- In the last stage of this process, bituminous coal can be transformed into **anthracite,** the oldest and **highest-quality type** of coal noted for its outstanding **energy-yielding capabilities.**

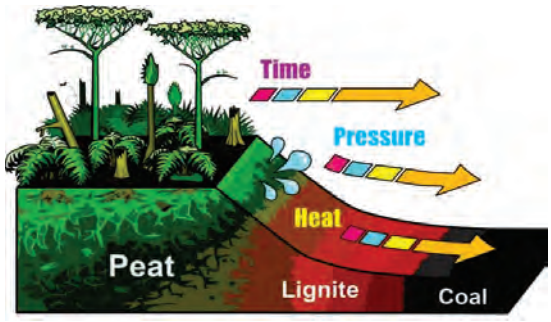


Fig. 4.3: Stages of Coal Formation

Classification of Coal

Coal, a major player in the global energy sector, is divided into several groups based on its **carbon, oxygen, and hydrogen concentrations,** among other factors. These groups represent coal's various applications and environmental implications.

- **Peat**
  - It contains less than **40 to 55 percent carbon** and is **heavy in impurities** and volatile materials, as well as moisture.
  - When burned, it produces a substantial amount of **smoke,** which contributes to pollution.
  - In its natural state, peat burns **similarly to wood,** producing less heat, creating more smoke, and leaving a large amount of ash.
- **Lignite**
  - It is often known as **brown coal** and has a carbon content ranging from **60-70 %,** but is remarkable for its **high moisture content** (more than 35 percent).
  - A key disadvantage of lignite is its **propensity for spontaneous combustion,** which increases the danger of fire mishaps in mining activities.
  - Lignite deposits are mostly found in **Rajasthan, Gujrat, Jammu and Kashmir, and Tamil Nadu.**
- **Bituminous**
  - Also known as **black coal,** bituminous coal is **soft, dense, and compact, with 69 to 86 % percent carbon.**
  - It is the most readily available and commonly used sort of coal, named after bitumen, a liquid material.

- Bituminous coal has a **low moisture and volatile content,** often ranging from **5 to 45%,** and has no trace of the original vegetative material.
- Its **high calorific value**, owing to its high carbon content and low moisture levels, makes it widely employed in the manufacturing of **coke and gas.**
- This coal is widely spread in states such as **Jharkhand, Odisha, West Bengal, Chhattisgarh, and Madhya Pradesh.**

❑ **Anthracite**

- It is known for its **semi-metallic sheen** and is the **highest-quality hard coal,** comprising **approximately 86 to 98% percent carbon.**
- It has little moisture and **volatile materials, ignites slowly,** resulting in minimum heat loss, and is extremely efficient.

Distribution of Coal in the World

The landscape of global coal reserves and the coal business is dynamic, with major changes in production, export, and consumption trends.

❑ **Global Coal Reserves**

- By the first half of 2023, worldwide coal demand had increased by nearly **1.5% to around 4.7 billion tonnes.**
- This growth demonstrated coal's continued importance in the global energy mix.
- Major coal reserves were discovered in the **United States, Russia, Australia, China, and India.**

❑ **Major Coal Producers**

- **China, India, and Indonesia** have emerged as the top coal producers, each achieving record production levels in 2022.
- **The United States and Australia** also play significant roles in the global coal supply, highlighting their importance in the industry.

❑ **Major Coal Exporters**

- **Australia and South Africa** are among the top coal exporters.
- The **United States** has seen significant growth in thermal coal exports, reaching a **5-year high in 2023,** indicating its growing prominence in the global coal trade.

❑ **Major Coal Consumers**

- **China and India** are the major coal consumers, accounting for over half of total global coal imports.
- This underlines their significant reliance on coal for energy needs.
- Other big customers include the **Philippines, Turkey, and Vietnam,** highlighting coal's extensive use in many regions.

❑ **Areas with Major Coal Reserves**

- In the **United States, Wyoming and West Virginia** are notable for their substantial coal reserves.

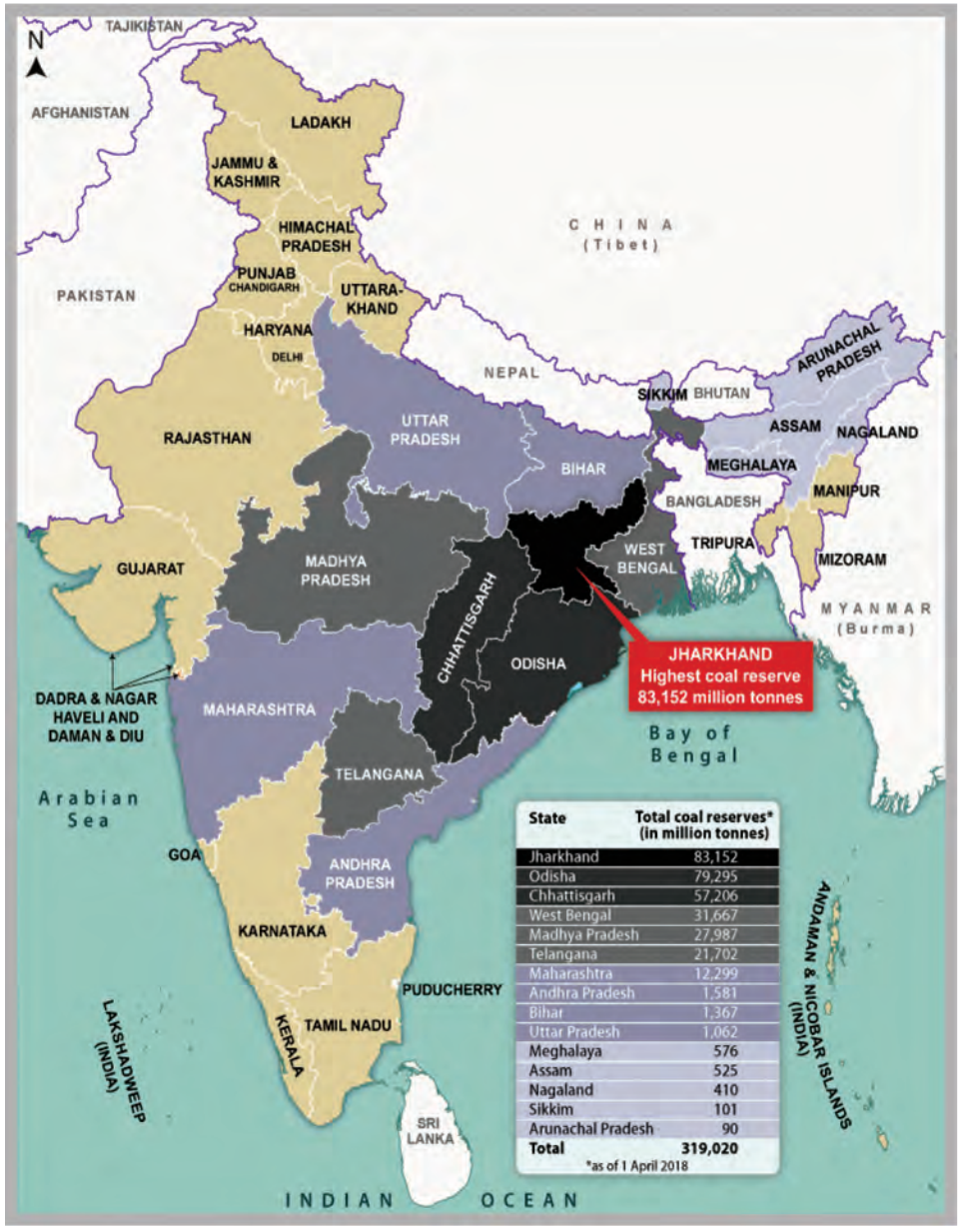


Fig. 4.4: Coal Reserves of India

- In **Australia, Queensland and New South Wales** were the main areas harbouring major coal reserves.

Despite the global trend towards renewable energy, coal has remained a significant resource, particularly for power production and industrial applications, demonstrating its long-term relevance in the global energy landscape.

Distribution of Coal in India

India's coal reserves are a significant aspect of its energy landscape, with notable characteristics and distribution. The following is the distribution of coal in India:

- **Size of Reserves:** India's coal reserves are **larger than its oil and petroleum reserves,** highlighting the country's reliance on coal as a primary energy source.
- **Origin of Coal Reserves:** Approximately **98% of India's coal reserves** and nearly all of its coal production are sourced from the **Gondwana fields.** These ancient coal deposits are crucial to the country's energy sector.
- **Characteristics of Gondwana Coal**
  - **Volatile Compounds and Ash Content:** Gondwana coal contains upto **30% ash,** which limits the carbon percentage to **below 60%.**
  - **Moisture, Sulphur, and Phosphorus:** This coal type is known for being free from moisture but contains sulphur and phosphorus.
  - **Types of Coal Produced:** The Gondwana coal fields yield **both coking and non-coking coal,** as well as bituminous coal. However, anthracite is generally not found in these fields.
- **Major coalfields in the Damuda Series (Lower Gondwana)**
  - The **Damuda series** holds the most extensively worked coalfields in India, contributing to **80%** of the country's total coal production.
- **Location of Coal Deposits:** These coal deposits are located in the valleys of specific rivers, including:
  - The **Damodar Valley** (spanning Jharkhand and West Bengal)
  - The **Mahanadi Valley** (in Chhattisgarh and Odisha)
  - The **Son Valley** (across Madhya Pradesh and Jharkhand)
  - The **Godavari and Wardha regions** (in Maharashtra and Andhra Pradesh)

State	Coal Reserves and Characteristics
Jharkhand	❑ Jharkhand is the heartland of India's coal fields, hosting the majority of the country's coal reserves. ❑ **Key coal fields include** Bokaro, Jharia, Deltenganj, Dhanbad, Auranga (Palamu), Giridh, Karanpura, Ramgarh, Hutar, Devgarh, and Rajmahal. ❑ The Jharia coalfield is particularly notable as one of the oldest and richest in India, containing some of the finest metallurgical coal (bituminous coking coal) in the country.
Odisha	❑ In Odisha, coal deposits are primarily found in the Sambalpur, Dhenkanal, and Sundargarh districts. ❑ **The Talchar coalfield,** spanning the Dhenkanal and Sambalpur districts, covers about 1800 sq.kms. ❑ Other significant coalfields include Rampur-Himgir and the Ib River.

Byproducts of Coal

In India, the coal industry not only provides significant energy but also generates a variety of byproducts with a wide range of applications.

- **Coke:** This is a **hard, porous** substance derived from coal and is primarily used in the iron and steel industries as a fuel and reducing agent.
- **Coal Tar:** A thick, black liquid obtained during the destructive distillation of coal, coal tar is used in manufacturing **chemicals, paints, synthetic dyes, and photographic materials.**
- **Coal Gas:** Produced during the coking process, coal gas is mainly composed of **methane, carbon monoxide and hydrogen** and is used as a fuel in industrial processes. It can also be converted into liquid fuel for transportation.
- **Fly Ash:** Generated during the combustion of coal in thermal power plants, fly ash is utilised in the **construction industry,** particularly in cement manufacturing and concrete production.
- **Bottom Ash and Slag:** These are coarse, granular, incombustible byproducts collected from the bottom of coal-burning furnaces. They find use in **road construction** and as aggregates in concrete.
- **Gypsum:** A byproduct of **flue-gas desulfurization** in power plants, gypsum is used in the construction industry for manufacturing drywall and plaster, and in cement production.

Coal byproducts in India play an important part in a variety of industrial processes, helping to reduce waste and finding applications in other sectors. These byproducts, ranging from coke to gypsum, demonstrate the multifarious utility of coal aside from its fundamental role as an energy source.

Clean coal technology: It encompasses a range of techniques and technologies aimed at reducing the environmental impact of coal energy production. Despite coal's reputation for being a dirty source of energy due to its significant emissions and contribution to global warming, clean coal technologies seek to mitigate these effects through several key approaches:

- **Coal Preparation:** Techniques like coal washing remove impurities from coal by mixing crushed coal with a liquid to separate unwanted minerals.

- **Emission Control:** Technologies such as wet scrubbers, low-NOx burners, and electrostatic precipitators are used to reduce emissions of sulfur dioxide, nitrogen oxides, and particulates. These help in minimizing acid rain, ground-level ozone, and respiratory problems associated with coal combustion.
- **Gasification:** This process converts coal into syngas (a mixture of carbon monoxide and hydrogen) without direct burning, reducing the amount of pollutants released.
- **Carbon Capture and Storage (CCS):** CCS is a critical component of clean coal technology, aiming to capture carbon dioxide emissions from power plants and other sources, and then sequestering it away from the atmosphere. Techniques include flue-gas separation, oxy-fuel combustion, and pre-combustion capture.
- **Storage Options:** Captured CO_2 can be stored in geological formations, depleted oil fields, deep saline aquifers, or unmineable coal seams to prevent its release into the atmosphere.

Conservation of Coal

Coal is a major source of energy in India, but its scarcity and environmental consequences need efficient conservation efforts. The Indian government has recognised this need and has been actively working to promote sustainable coal handling. Following are the strategies for coal conservation in India:

- **Efficient Utilisation:** Emphasising the use of advanced technologies to enhance the efficiency of coal use in power generation and industrial processes.
- **Alternative Energy Sources:** Promoting renewable energy sources like solar, wind, and hydropower to reduce dependence on coal.
- **Improved Mining Techniques:** Implementing modern mining technologies for more efficient coal extraction, thereby reducing wastage and environmental damage.
- **Energy Conservation Measures:** Encouraging the adoption of energy-saving practices and the use of energy-efficient appliances to lower the demand for coal.
- **Recycling and Reuse:** Utilising coal byproducts in various industrial processes to minimise the need for fresh coal extraction.
- **Policy and Regulation:** The Indian government has introduced policies and regulations to promote cleaner energy sources and support research in energy efficiency.
- **Public Awareness:** Raising awareness about the importance of energy conservation and the environmental impacts of coal usage.

Coal Sector Reforms in India

The Indian government has enacted a number of **coal-related reforms** with the goal of **boosting efficiency, promoting openness, and stimulating private investment.** These reforms were aimed at solving the coal sector's issues, which include, environmental concerns, production inefficiencies, and a coal mining monopoly.

- **Commercial Mining and Auctions**
  - The government opened the coal sector to **private players** by allowing **commercial mining** and removing restrictions on the end-use of coal.
  - This was a significant shift from the earlier practice, where coal mining was largely restricted to **state-owned entities.** The introduction of a revenue-sharing model in auctions instead of a fixed fee per tonne has made bidding more competitive and transparent.
- **Single Window Clearance System**
  - To streamline the process and reduce the time required for obtaining various clearances, the government introduced a **single-window clearance system.**
  - This system is aimed at speeding up the operationalization of coal mines.
- **FDI Policy Revision**
  - The government revised its **Foreign Direct Investment (FDI) policy** to allow **100% FDI** under the **automatic route for coal mining,** associated infrastructure, and sales, further aiming to attract international players into the Indian coal sector.
- **Infrastructure Development**
  - Efforts have been made to improve the coal evacuation infrastructure, including the development of **rail corridors** in major coal-producing areas to enhance transportation efficiency.
- **Environmental and Sustainable Measures**
  - The government has also focused on adopting cleaner coal technologies and ensuring environmental sustainability in coal mining operations. Initiatives include promoting **coal gasification and liquefaction,** setting up coal washeries, and reclamation of mining areas.

These reforms have led to increased competition, efficiency, and transparency in the coal sector, contributing to higher revenues for the government and potentially reducing India's dependence on coal imports. The introduction of commercial mining is particularly expected to increase coal production and make India self-sufficient in meeting its coal requirements.

Why India Imports Coal Despite Having Ample Reserves?

Inability to Exploit Reserves: A significant factor hindering the full utilization of India's coal reserves is the lack of technology for deep underground mining. About 40% of these reserves are located at depths requiring advanced mining techniques, which India currently lacks. Additionally, a considerable portion of the coal reserves is situated in areas affected by Maoist insurgency and in densely populated regions, presenting logistical and security challenges.

Shortage of Coking Coal: Coking coal, crucial for iron production in blast furnaces, is scarce in India. This shortage compels India to rely on imports from countries like Australia, Canada, South Africa, and Indonesia to fulfill its coking coal requirements.

Environmental Concerns: The coal found in India is characterized by high ash content and low calorific value, leading to significant pollution when burned. To mitigate this, many Indian power plants are designed to use higher-quality imported coal. The implementation of clean coal technology to reduce emissions is both costly and complex, which further encourages the preference for imported coal.

Lack of Dedicated Freight Corridors: The uneven distribution of coal resources within India, combined with the slow movement of freight due to shared railway tracks with passenger trains, poses logistical challenges. The absence of dedicated freight corridors for goods trains often makes importing coal more convenient and cost-effective.

Indian Government Initiatives for Coal Conservation

- **National Coal Conservation Policy:** This policy aims to ensure the **judicious use** of coal and reduce environmental impact.
- **Coal Bed Methane Policy:** Encouraging the extraction of **methane from coal seams** to reduce greenhouse gas emissions and utilise it as a clean energy source.
- **Research and Development:** Supporting R&D in clean coal technologies, including carbon capture and storage.
- **Promotion of Coal Washeries:** Encouraging the establishment of coal washeries to improve the quality of coal and reduce ash content, leading to more efficient usage.

In India, conserving coal requires a holistic approach that includes not only effective utilisation and the adoption of alternative energy sources but also strong government activities focused on sustainable coal management.

Petroleum

- Petroleum, also known as **"liquid gold,"** is a valuable energy source derived from sedimentary rocks beneath the Earth's crust.
- It is primarily made up of **hydrocarbons** (90 to 95%), although it also contains organic molecules containing oxygen, nitrogen, sulphur, and trace amounts of organometallic compounds.
- Petroleum was formed millions of years ago from the remains of ancient sea animals, changing organic matter into oil and gas under extreme heat and pressure.

Nature and Properties of Petroleum

- Petroleum's composition and qualities are as diverse as its use. It is a complicated mixture of hydrocarbons whose composition varies greatly depending on the source.
- The physical properties of petroleum, such as colour, viscosity, and density, can vary greatly.
- For example, it can vary from a thin, volatile, clear liquid to a thick, semi-solid substance.
- Petroleum's chemical composition makes it a great fuel source since the hydrocarbons in it may release huge amounts of energy when combusted.

Distribution of Petroleum in the World

Petroleum is a key component of the global energy mix, being an essential raw material for a wide range of businesses globally. Despite the search for renewable energy sources, economic growth and industrial development continue to drive strong demand for petroleum products. The distribution of petroleum reserves is critical to the balance of global energy dynamics, as certain regions wield considerable power due to their massive oil deposits.

Petroleum Reserves across the World

- **Global Oil Reserves:** At the end of 2023, the world's proven oil reserves reached **1,754.6 billion** barrels, marking an increase from the previous year's total of **1,746.8** billion barrels.
- **Main Countries with Significant Petroleum Reserves**
  - **Venezuela:** Leads with the highest reported reserves, contributing significantly to the global oil reserves pool.
  - **Saudi Arabia:** Continues to be a dominant player with its vast reserves, crucial for the global oil market.
  - **Canada:** Notable for its oil sands, Canada remains a key contributor to global petroleum reserves.
  - **Iran:** With substantial reserves, Iran plays a significant role in the Middle East's contribution to global oil reserves.

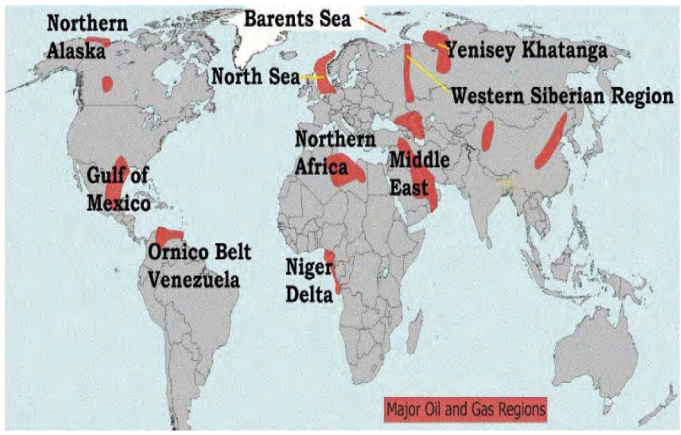


Fig. 4.5: Distribution of Petroleum in the World

These reserves are spread throughout a variety of geological formations, with the **Middle East, Canada's oil sands, Venezuela's Orinoco Belt, and Russia's Siberian fields** among the most prominent. The careful management of these reserves is critical to guaranteeing energy security and supporting the economies of oil-rich countries.

- **Global Petroleum Production**
  - **The United States** continues to lead in oil supply growth, with output surpassing the **20 million barrels per day** (mb/d) mark, contributing significantly to global petroleum supply.
  - **Brazil and Guyana:** Both countries have seen record production levels, further boosting the global oil output.
- **Global Petroleum Consumption**
  - **Global Demand:** The demand for crude oil, including biofuels, amounted to 99.57 million barrels per day in 2022
  - **Growth** in global demand is anchored by robust demand from China, which is responsible for 77% of the increase, followed by India and Brazil.
- **Global Petroleum Exports:** The ranking of the countries changes due to various circumstances. But historically, countries like **Saudi Arabia, Russia, Iraq, Canada, and the United Arab Emirates** have been among the top oil exporters.

OPEC and Its Role in Oil Trade

- **The Organisation of Petroleum Exporting Countries (OPEC)** is a key player in the global oil trade, representing some of the world's largest oil producers.
- OPEC was **founded in Baghdad, Iraq, in 1960**, and its initial members were Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela.
- Over time, its membership has grown to include other oil-producing countries, with the goal of coordinating and unifying petroleum policies among member countries as well as ensuring oil market stability to ensure an efficient, economic, and regular supply of petroleum to consumers, a consistent income for producers, and a fair return on capital for those investing in the petroleum industry.
- **Role of OPEC in Oil Trade**
  - **Market Stabilisation:** OPEC plays a crucial role in **stabilising the global oil market** by adjusting its oil output in response to fluctuations in demand and supply. This helps in managing oil prices, preventing extreme volatility that could adversely affect both producers and consumers globally.
  - **Production Quotas:** One of the primary tools OPEC uses to **influence the oil market** is through the allocation of oil production quotas to its member countries. These quotas are designed to control the supply of oil in the market, thereby influencing oil prices.
  - **Policy Coordination:** OPEC serves as a platform for **oil-producing countries** to coordinate their energy policies and strategies. By working together, OPEC members can better manage their resources and respond to global energy challenges.
  - **Research and Analysis:** OPEC conducts research and provides analysis on the global oil market, offering **valuable insights** into trends, forecasts, and the impact of various factors on oil demand and supply. This information supports decision-making processes within the organisation and among its member states.
  - **Global Energy Dialogue:** OPEC engages in dialogue with other countries, international organisations, and stakeholders in the global energy sector. This fosters **cooperation** and understanding on issues related to energy security, economic development, and environmental sustainability.

OPEC's choices and policies have a considerable impact on the global oil market, impacting both pricing and output levels. While OPEC tries to maintain oil market stability, its actions are frequently scrutinised and debated, reflecting the complex dynamics of global energy politics and economics.

Distribution of Petroleum in India

- Mineral oil formation in India dates back to the **Tertiary period,** approximately **3 million years ago,** with the country's oil reserves primarily connected with **anticlines and fault traps** in sedimentary rock formations from this age.
- This time period was characterised by favourable conditions for oil creation, particularly in the lower and middle Tertiary periods, when dense forests and sea creatures thrived in gulfs, estuaries, deltas, and surrounding areas.

❑ **The following table gives state-wise reserves in India:**

State	Reserves and Significance
Assam Oil Fields	❑ Assam is recognised as the oldest oil-producing state in India, with the Digboi field in the Dibrugarh district being the oldest oil field in the country. ❑ Other significant fields include the Naharkatiya field and the Moran-Hugrijan field. ❑ The primary oil-bearing strata in Assam extend approximately 320 kilometers within the upper Assam along the Brahmaputra valley, marking a rich history and substantial contribution to India's oil production.
Gujarat Oil Fields	❑ Gujarat is home to several important oilfields, including Ankleshwar, Khambhat, Ahmedabad, Barkol, and Sanand. ❑ The oil extracted from these fields is transported to refineries at Trombay and Koyali for processing, underscoring Gujarat's pivotal role in India's oil industry.
Rajasthan Oil Fields	❑ Rajasthan has emerged as the largest onshore oil-producing state in India, marking a significant milestone with one of the most substantial inland oil discoveries in the Barmer district. ❑ The Mangala oil field, along with Saraswati and Rajeshwari, are among the crucial discoveries in the state, highlighting Rajasthan's growing importance in contributing to India's energy security.

❑ **On-shore Oil Production in India:** India's on-shore oil production is spread across several key regions:

- **Brahmaputra Valley** in northeastern India is a significant on-shore oil production area, contributing to the country's oil reserves.
- **Barmer area in Rajasthan**, known for its oil fields, plays a crucial role in enhancing India's oil production capacity.
- **Gujarat coast along the western part of India** is another vital region for on-shore oil production, with its extensive sedimentary formations.
- **Cauvery on-shore basins in Tamil Nadu and Andhra Pradesh** are notable for their on-shore (and, in the case of Andhra Pradesh, offshore as well) oil reserves, adding to the diversity of India's oil production landscape.

❑ **Offshore Oil Production in India:** Offshore oil production is strategically important for India, with significant exploration and production activities on both the Western and Eastern coasts.

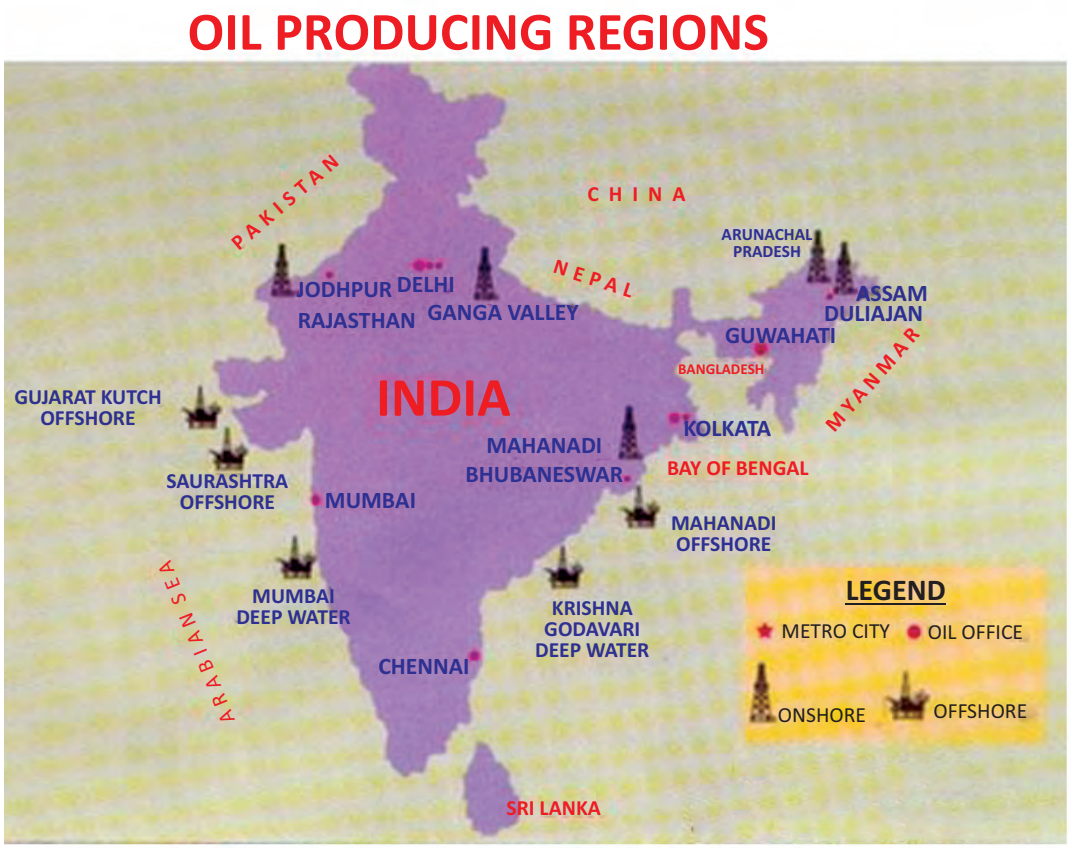


Fig. 4.6: Distribution of Oil in India

- **Western Coast:** The **Mumbai High, Bassein, and Aliabet** are among the most productive offshore sites, contributing significantly to India's oil output.
- **Eastern Coast:** The **Krishna-Godavari and Cauvery basins** are key offshore areas, enhancing India's energy resources and supporting its energy security and economic development.

❑ **India's Strategic Oil Reserves**

- Recognising the need for energy security, India formed the **Indian Strategic Petroleum Reserves Ltd. (ISPRL).**
- As of 2023, India's strategic reserves are intended to hold **more than 5 million metric tonnes of crude oil,** which is equivalent to around 9–10 days of crude oil consumption.
- These reserves are located in underground rock caves in three locations: **Visakhapatnam in Andhra Pradesh, Mangalore in Karnataka, and Padur in Kerala.**
- India intends to increase its energy reserves in response to rising demand and anticipated supply disruptions.

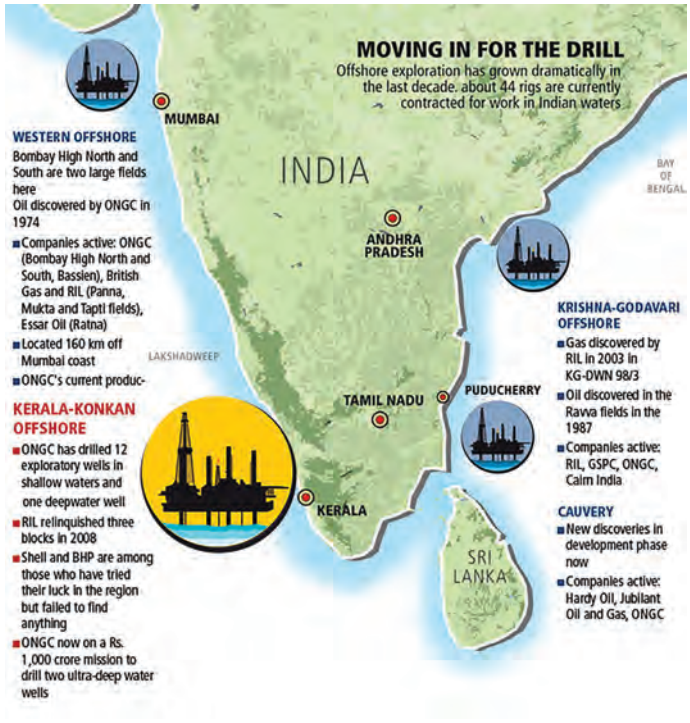

MOVING IN FOR THE DRILL
Offshore exploration has grown dramatically in the last decade. about 44 rigs are currently contracted for work in Indian waters
MUMBAI
INDIA
BAY OF BENGAL
ANDHRA PRADESH
TAMIL NADU
PUDUCHERRY
KERALA
LAKSHADWEEP
SRI LANKA
WESTERN OFFSHORE
Bombay High North and South are two large fields here
Oil discovered by ONGC in 1974
Companies active: ONGC (Bombay High North and South, Bassien), British Gas and RIL (Panna, Mukta and Tapti fields), Essar Oil (Ratna)
Located 160 km off Mumbai coast
ONGC's current produc-
KERALA-KONKAN OFFSHORE
ONGC has drilled 12 exploratory wells in shallow waters and one deepwater well
RIL relinquished three blocks in 2008
Shell and BHP are among those who have tried their luck in the region but failed to find anything
ONGC now on a Rs. 1,000 crore mission to drill two ultra-deep water wells
KRISHNA-GODAVARI OFFSHORE
Gas discovered by RIL in 2003 in KG-DWN 98/3
Oil discovered in the Ravva fields in the 1987
Companies active: RIL, GSPC, ONGC, Cairn India
CAUVERY
New discoveries in development phase now
Companies active: Hardy Oil, Jubilant Oil and Gas, ONGC

Fig. 4.7: Offshore Oil Production Sites of India

❑ **New Strategic Oil Reserve Sites in India:** The Indian government has identified additional locations for expanding its strategic petroleum reserves. These include:

- **Chandikhol in Odisha:** Identified as a site for a **new strategic petroleum reserve,** Chandikhol is expected to considerably contribute to India's oil storage capacity, hence improving the eastern region's energy security.
- **Padur in Karnataka (Expansion):** In addition to the existing facility, Padur is set to expand further, enhancing its capacity to store more crude oil.
- **Rajkot in Gujarat:** Rajkot is another site **under consideration** for the building of a strategic petroleum reserve. Its inclusion indicates the government's commitment to ensuring energy security throughout the country.

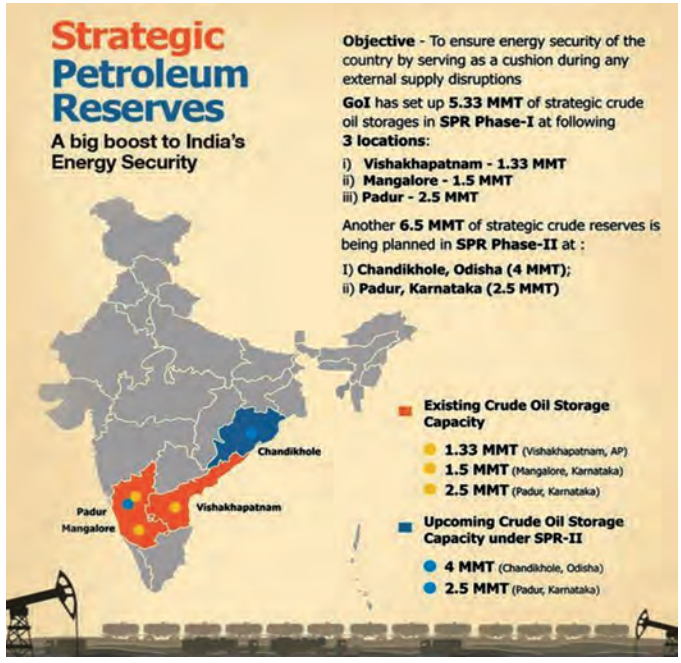

Strategic Petroleum Reserves
A big boost to India's Energy Security
Objective - To ensure energy security of the country by serving as a cushion during any external supply disruptions
GoI has set up 5.33 MMT of strategic crude oil storages in SPR Phase-I at following 3 locations:
i) Vishakhapatnam - 1.33 MMT
ii) Mangalore - 1.5 MMT
iii) Padur - 2.5 MMT
Another 6.5 MMT of strategic crude reserves is being planned in SPR Phase-II at :
I) Chandikhole, Odisha (4 MMT);
ii) Padur, Karnataka (2.5 MMT)
Chandikhole
Vishakhapatnam
Padur
Mangalore
Existing Crude Oil Storage Capacity
1.33 MMT (Vishakhapatnam, AP)
1.5 MMT (Mangalore, Karnataka)
2.5 MMT (Padur, Karnataka)
Upcoming Crude Oil Storage Capacity under SPR-II
4 MMT (Chandikhole, Odisha)
2.5 MMT (Padur, Karnataka)

Fig. 4.8: Strategic Oil Reserves of India

The strategic reserves supplement India's existing storage capacity and are meant to be used in emergencies to reduce the impact of price volatility and supply interruptions on the Indian economy. The Indian government continues to look into ways to increase these reserves, reflecting the country's increased emphasis on energy security in the face of expanding energy consumption.

Crude Oil Pricing in India

❑ India, as the **world's third-largest user of crude oil**, relies largely on imports to meet its energy needs.

❑ **Brent Crude and West Texas Intermediate (WTI)** benchmark crude oil prices, as well as other elements like exchange rates, taxes, and subsidies, determine crude oil prices in India.

❑ **The Evolution of Petrol Pricing in India**

- **Prior to 2014,** the government set and updated petrol prices **every 15 days.**
- This approach provided **consistency,** but it also resulted in major under-recoveries for **oil marketing companies** (OMCs) during periods of rising world oil prices.
- **2014 Deregulation:** The government **deregulated fuel and diesel prices,** enabling market forces to determine their value.

- This was a big policy change towards making India's fuel sector more **competitive and efficient.**
- **Daily Price Revisions Since 2017:** In June 2017, India implemented a **dynamic pricing** strategy for petrol and diesel. Under this arrangement, **Oil Marketing Companies (OMCs) alter fuel prices daily** to reflect changes in international crude oil prices and the INR-USD exchange rate.
- The following table gives a difference between Brent crude oil and West Texas Intermediate Crude Oil

Feature	Brent Crude Oil	WTI Crude Oil
Extraction Locations	Produced in the North Sea region of the Atlantic Ocean, specifically between Norway and the Shetlands.	Extracted mainly from the Permian Basin in west Texas and southeastern New Mexico, United States.
Content and Composition	Light and sweet, with an API gravity of 39.8 percent and a sulphur content of 0.37 percent.	It is also light and sweet, possessing an API gravity of 39.6 percent and a sulphur content ranging between 0.24 and 0.34 percent.
Geopolitical Influences	Can significantly affect the international community and global financial markets, especially during military conflicts in Eastern Europe.	Influences geopolitics more today than in the past, especially with the US exporting nearly three million barrels per day to over 100 countries.
Trading Exchange	Traded on London's Intercontinental Exchange (ICE) futures exchange.	Assessed on the New York Mercantile Exchange (NYMEX), determining the spot price for US oil.
Pricing and benchmarks	It is considered more of an international benchmark, covering a wider geography, which can contribute to its typically having a higher price compared to US crude.	Priced in US dollars, like Brent, but production levels in the US can be a fundamental driver of contract spreads between WTI and Brent.

- **How Petrol Price Is Calculated in India:** The daily price of petrol in India is calculated based on several components:
  - **International Crude Oil Prices:** Fluctuating and subject to factors such as global supply and demand, international crude oil prices are what determine the base price of gasoline.
  - **Exchange rate:** The value of the **Indian rupee in relation to the US dollar** affects the cost of importing crude oil. Fluctuations in the exchange rate directly impact petrol pricing.
  - **Refining and Transportation Costs:** After importing, crude oil is refined into petrol, incurring additional costs. Transportation from refineries to distribution points further adds to the price.
  - **Excise Duty and VAT:** The central government levies an **excise duty on petrol,** while state governments charge **Value Added Tax (VAT).** These taxes are significant contributors to the final retail price of petrol.
  - **Dealer Commission:** Finally, petrol pump dealers receive a **commission** for selling the fuel, which is included in the retail price.
- The dynamic pricing model for petrol in India marks a big step towards linking the domestic fuel market with global energy markets. By revising fuel prices on a daily basis, oil marketing companies (OMCs) can better control operating costs and quickly pass on the benefits of decreased worldwide oil prices to consumers. However, this approach means that consumers and the economy are directly affected by global oil price volatility.

Natural Gas

- Natural gas is a **colourless and odourless gas** found deep beneath the earth's surface.
- It is commonly found near oil resources, but it can also be found in big natural gas fields on its own.
- Natural gas extraction and use have skyrocketed in recent years, owing to technological improvements and a global push for cleaner energy.
- It is seen as a **more environmentally friendly** alternative to traditional fossil fuels, producing fewer pollutants and greenhouse gases when burned.
- The following table shows difference between **CNG, LPG, and LNG:**

Fuel Type	Composition	Usage	Safety and Environmental Impact
CNG (Compressed Natural Gas)	❑ Composed of 93.05% methane, with nitrogen, carbon dioxide, propane, and traces of ethane.	❑ Used as a substitute for gasoline in automobiles. Adaptable to modern engines and has a high octane rating.	❑ It emits a lower percentage of greenhouse gases compared to other fuels. It is considered safer as it dissipates quickly in the event of a leak.
LPG (Liquefied Petroleum Gas)	❑ A mixture of propane and butane, with traces of propylene and butylene. Liquefied gas and a byproduct of crude petroleum extraction.	❑ Commonly used in the industrial, refrigeration, agricultural, and catering industries. Also powers cooking and heating in homes.	❑ It emits fewer hydrocarbons, carbon monoxide, and oxides of nitrogen than gasoline. It is heavier than air, so it settles on the ground in case of a spill, which poses a risk.
LNG (Liquefied Natural Gas)	❑ Primarily methane (about 95%), with nitrogen, ethane, carbon dioxide, and propane. Converted to liquid form through liquefaction.	❑ Due to its energy density, long-haul trucking companies prefer it. Is comparable to diesel fuel. Requires special handling and equipment for refueling.	❑ Non-toxic and non-corrosive, resulting in less pollution. However, it requires freezing for liquefaction and takes up less storage space than CNG.

- **Natural Gas Processes:** The journey of natural gas from its underground reservoirs to end-users involves several key processes:
- **Exploration and Production:** The first step involves **exploring and drilling** to locate natural gas reserves. Advanced technologies, like seismic surveys, are used to identify potential gas deposits.
- **Processing:** Once extracted, natural gas undergoes processing to **remove impurities and separate** other hydrocarbons and fluids. This process ensures that the gas is clean and meets market specifications.
- **Transportation:** Processed natural gas is transported mainly through **pipelines** over long distances from production sites to consumption areas. **Liquefied natural gas (LNG)** technology also allows for transportation by sea to regions not connected by pipelines.
- **Storage:** Natural gas can be stored in underground reservoirs to manage supply and demand, ensuring availability during peak consumption periods or supply disruptions.
- **Distribution:** Finally, natural gas is distributed to consumers through a network of pipelines for residential, commercial, and industrial use.
- Natural gas has a significant impact on the global energy landscape, providing a cleaner alternative to traditional fossil fuels. Its adaptability and minimal environmental impact make it an essential component in the move towards more sustainable energy systems. As technology progresses and the globe strives to reduce carbon emissions, natural gas is expected to remain an important energy source.

Global Distribution of Natural Gas

The worldwide natural gas market continues to play an important role in the energy industry, with considerable increases in production, consumption, and exports across countries.

Global Natural Gas Production

- **United States:** Leading the world in natural gas production, the US has capitalised on its **shale gas reserves** through technologies like **hydraulic fracturing,** influencing global supply dynamics.
- **Russia:** As a major player, Russia's vast reserves, especially in Siberia, are central to its substantial natural gas output. However, in 2023, gas production in Russia **fell by 12%** due to reduced exports to Europe, highlighting the impact of geopolitical tensions on the natural gas market.
- **Qatar:** With the **world's third-largest reserves of natural gas**, Qatar remains a dominant force in LNG production and export, particularly from its North Field.
- **Global Natural Gas Consumption**
  - **Asia-Pacific Region:** As a result of rising energy needs and a shift towards **cleaner energy** sources, demand for natural gas has increased in nations like **China and India.** Global gas consumption in 2023 was forecast to rise by around 1% year on year (Gas Exporting Countries Forum), with significant contributions from the **US, China, and emerging markets in the Asia-Pacific region.**
  - **Europe:** European countries depend heavily on natural gas for **heating and electricity,** relying on imports from **Russia, Norway,** and LNG suppliers to meet their needs.

❑ Global Natural Gas Export

- **Leading exporters: Qatar, the United States, and Australia** are at the forefront of LNG exports, addressing the global demand for cleaner fossil fuels. Qatar and Australia have significant LNG export capacities, while the US has seen rapid expansion in its LNG export capabilities.
- **LNG Market Dynamics:** The value of global LNG trade doubled in 2022 to an all-time high of USD **450 billion,** despite a modest volumetric increase of **5.5%,** indicating the growing importance and profitability of LNG exports.

Natural gas is a critical component of the global energy balance, with the United States, Russia, and Qatar dominating in production and exports, and an increasing demand in Asia and Europe. The dynamics of LNG exports demonstrate the industry's resilience and agility in fulfilling global energy demands.

Distribution of Natural Gas in India

India's natural gas sector is an important part of its energy security, reflecting the country's expanding energy demands and strategic shift towards a more diverse and cleaner energy mix.

❑ Locations of Natural Gas Reserves in India

- **Krishna-Godavari Basin:** Located off the eastern coast, this basin is one of the most significant sources of natural gas in India. Numerous significant discoveries have occurred there in recent years, most notably the deep-water gas fields run by **Reliance Industries** and the state-owned **Oil and Natural Gas Corporation (ONGC).**
- **Mumbai High:** Situated off the western coast of India, Mumbai High is primarily known for its oil, but it also contains **substantial natural gas reserves.** It has been a critical source of energy for India for decades.
- **Cauvery Basin:** This basin in the southern part of India, both **onshore and offshore**, has shown promising reserves of natural gas. Exploration and production activities have been ongoing, with both public and private sector involvement.

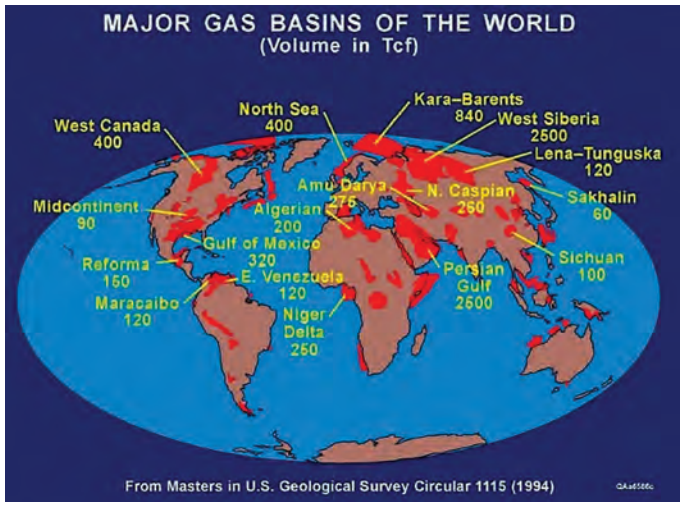


Fig. 4.9: Major Gas Basins of the World

- **Assam-Arakan Basin:** Located in the northeastern part of India, this basin is known for its rich hydrocarbon resources, including natural gas. It plays a crucial role in supplying natural gas to India's **northeastern states.**
- **Cambay Basin:** Situated in Gujarat, western India, the Cambay Basin has been a source of both oil and natural gas. It has seen increased exploration activities aimed at tapping into its unconventional hydrocarbon resources, such as **shale gas.**

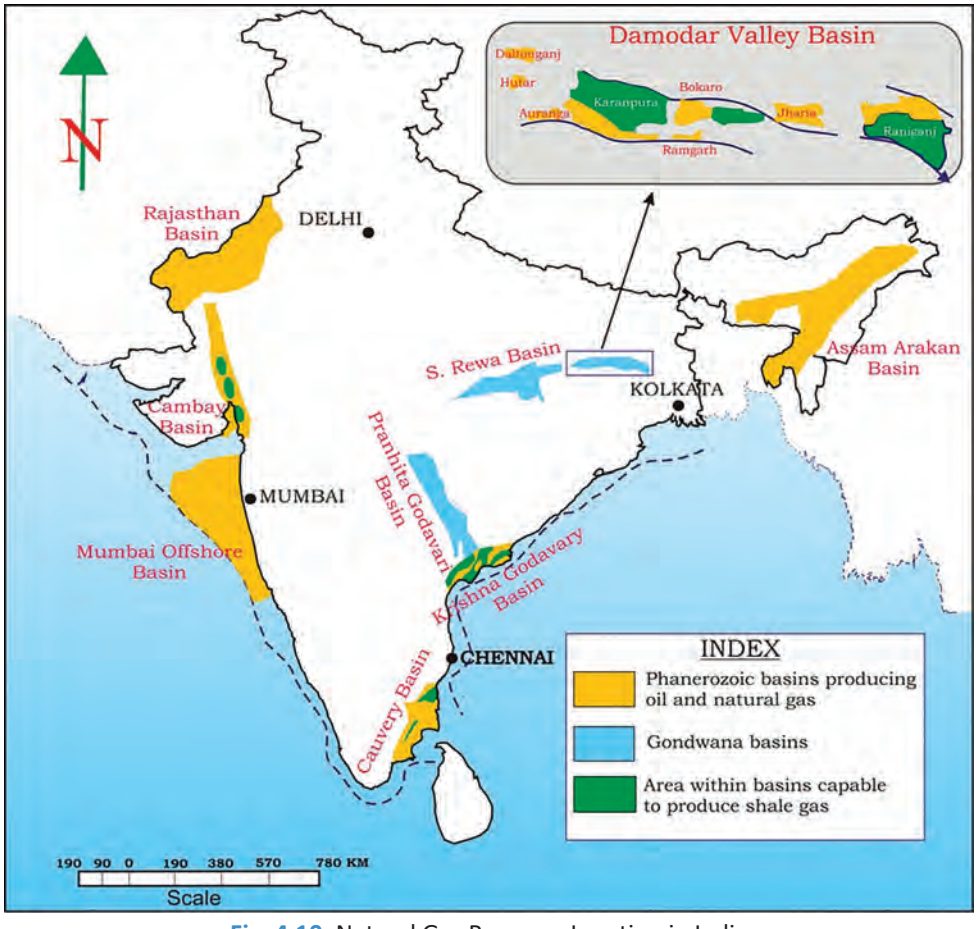


Fig. 4.10: Natural Gas Reserves Location in India

- **Reserves of Natural Gas**
  - India's natural gas reserves are significant, with proven reserves of **43 trillion cubic feet (Tcf) as of 2017,** placing it 22nd globally.
  - These reserves are equivalent to about **22.1 times** its annual consumption, suggesting India has approximately 22 years of gas left at current consumption levels.
  - The country's sedimentary basins, which span a total area of **3.4 million square kilometres** across land, shallow water, and deep water up to the **Exclusive Economic Zone (EEZ),** are the primary locations for these reserves.
- **Production and Consumption of Natural Gas in India**
  - India's natural gas production was **1,133,364 million cubic feet (MMcf) as of 2015,** ranking it 29th in the world.
  - However, its consumption outpaces production significantly. In 2017, India consumed **1,957,546 MMcf** of natural gas, making it the 14th largest consumer worldwide.
- **Imports**
  - To bridge the gap between production and consumption, India relies heavily on natural gas imports.
  - In 2015, it imported 649,796 MMcf of natural gas, which constituted about **37%** of its total consumption.
  - The trend of heavy reliance on imports continues, with India being the **4th largest importer of liquefied natural gas (LNG) globally.**

India's Natural Gas Sector

- **Exploration and Production (E&P) Initiatives:** The Indian government has been actively promoting exploration and production activities through policies like the **Hydrocarbon Exploration and Licencing Policy (HELP), Open Acreage Licencing Policy (OALP),** and the **Discovered Small Field (DSF) policy.** These initiatives aim to attract investment and technology to explore and develop India's hydrocarbon resources.
- **Infrastructure Development:** To support the increasing demand for natural gas, India is expanding its gas pipeline network. As of September 2023, about **23,298 km of natural gas pipelines** are operational, with an additional **10,009 km under construction.** This expansion aims to enhance the availability and accessibility of natural gas across the country.
- **Investment in LNG Terminals:** Recognising the importance of **liquefied natural gas (LNG)** in meeting its energy needs, India is investing in LNG infrastructure. With operational LNG terminals and more in the pipeline, India is enhancing its capacity to import LNG, thereby **diversifying** its energy sources and ensuring energy security.
- **Government targets and policies:** The Indian government's target to increase the share of natural gas in its energy mix to **15% by 2030** underscores the strategic importance of natural gas. Policies aimed at increasing domestic production, improving infrastructure, and encouraging the use of natural gas in various sectors, including transportation and domestic cooking, are pivotal to achieving this goal.
- **Environmental Considerations:** Natural gas is seen as a **cleaner alternative** to coal and oil, helping India address its environmental concerns and meet its commitments under international agreements like the **Paris Agreement.** The shift towards natural gas is part of India's broader strategy to transition to a low-carbon economy.

Importance of Natural Gas

- Natural gas plays an important role in modern society, providing a variety of benefits that make it a key component of the global energy mix.
- **Cleaner burning:** Natural gas is the cleanest-burning fossil fuel. It emits significantly lower levels of harmful pollutants such as **sulphur dioxide (SO_2), nitrogen oxides (NOx), and particulate matter compared to coal or oil.** When used for electricity generation, natural gas produces half as much carbon dioxide (CO_2) as coal, making it a critical fuel in the transition towards a lower-carbon energy system.
- **Reliability and Flexibility:** Natural gas offers a reliable and flexible energy source. It can be used across various sectors, including power generation, heating, and as a fuel for vehicles. Its ability to provide a consistent energy supply makes it a vital backup for renewable energy sources like solar and wind, which can be intermittent.
- **Economic Benefits:** The natural gas industry contributes significantly to economic development by **creating jobs, generating tax revenue, and stimulating growth** in related sectors. The availability of natural gas can also lower energy costs for consumers and businesses, contributing to economic competitiveness.
- **Supports Renewable Energy Development:** Natural gas plays a complementary role in supporting the **growth of renewable energy.** It can quickly ramp up or down to balance the electricity grid when there is insufficient sun or wind, ensuring a stable energy supply and facilitating the integration of more renewable resources.
- **Versatility:** Natural gas is versatile and can be used in various applications, including power generation, heating, cooking, and as a feedstock for producing **chemicals, fertilisers, and hydrogen.** Its versatility makes it a valuable resource for meeting diverse energy needs.

- **Enhances Energy Security:** By diversifying the energy supply mix, natural gas can enhance energy security. Countries with access to natural gas resources or the ability to import natural gas can reduce their dependence on other, more polluting fossil fuels.
- **Supports Industrial Processes:** Natural gas is essential for various industrial processes, providing the **high temperatures** needed for the production of **steel, cement, glass,** and other materials. Its efficiency and lower emissions profile make it a preferred choice for industries looking to reduce their environmental impact.

Limitations of Natural Gas Usage

- **Environmental Impact:** When burned, it emits **carbon dioxide** as well as **methane** during extraction and transportation, which contribute to global warming.
- **Finite Resource:** Natural gas is a finite resource, with extraction technologies such as **fracking** increasing its supply but not addressing long-term depletion.
- **Issues about extraction and production:** Fracking techniques can **contaminate** water, pollute the air, and disturb ecosystems.
- **Infrastructure Challenges:** Building and maintaining natural gas infrastructure is **expensive,** and pipelines are prone to leaks and explosions.
- **Climate Goals Conflict:** The reliance on natural gas may impede the shift to renewable energy sources required to accomplish climate targets.
- **Geopolitical Dependencies:** An **uneven worldwide distribution** of natural gas reserves might result in supply vulnerabilities and geopolitical conflicts.
- **Safety Risks:** Natural gas is **highly combustible,** and leaks can cause huge explosions and fires.

Steps taken to promote Natural Gas in India

India has actively promoted the use of **natural gas as part of its energy mix** in order to provide energy security, minimise environmental pollution, and shift to a **gas-based economy.** The government has launched a number of policies and measures aimed at increasing natural gas's part in India's energy mix.

- **Pradhan Mantri Urja Ganga Project (PMUG):** This ambitious project aims to develop a **gas pipeline infrastructure in the eastern part of India,** connecting major energy hubs and industrial centers. The project is designed to facilitate the supply of natural gas for various uses, including residential, transportation, and industrial, thereby promoting the use of cleaner fuel.
- **City Gas Distribution (CGD) Networks:** The government has been expanding CGD networks across the country to provide **piped natural gas (PNG)** for **cooking** and **compressed natural gas (CNG) for transportation.** The **Petroleum and Natural Gas Regulatory Board (PNGRB)** conducts bidding rounds for CGD licences, significantly increasing the accessibility of natural gas to households and industries.
- **National Gas Grid:** The development of the National Gas Grid aims to ensure the **availability of natural gas across the country.** The grid connects major demand centers with supply sources, including imported **liquefied natural gas (LNG) terminals, domestic gas fields, and cross-border gas pipelines**. This infrastructure is crucial for enhancing national energy security and supporting the gas-based economy.
- **Gas Allocation and Pricing Reforms:** The government has introduced reforms in **gas allocation and pricing** to make natural gas more affordable and accessible. These reforms include the adoption of a new gas pricing formula linked to **global indices,** ensuring competitive pricing for consumers and fair returns for producers.
- **Use of LNG in Transportation:** To promote the use of natural gas in the transportation sector, the **government has been encouraging the adoption of LNG** as a fuel for **heavy vehicles.** This includes setting up LNG stations along major highways and providing incentives for the conversion of vehicles to LNG.
- **Hydrocarbon Exploration and Licensing Policy (HELP):** HELP encourages the exploration and production of hydrocarbons, including **natural gas,** under a **revenue-sharing model.** It offers marketing and pricing freedom for the natural gas produced from these fields, aiming to boost domestic production.

These steps reflect India's strategic approach to enhancing its natural gas infrastructure, accessibility, and usage across various sectors of the economy. By promoting natural gas, India aims to achieve a cleaner energy future, reduce its carbon footprint, and ensure sustainable economic growth.

Nuclear Energy

- Nuclear energy comes from the **nucleus of an atom,** which is made up of **protons and neutrons.**
- It can manifest as two main mechanisms: **nuclear fission,** in which atom nuclei divide into several smaller fragments, and **nuclear fusion,** in which nuclei merge.
- Nuclear fission is the most common technique of generating power from nuclear energy around the world, with nuclear fusion still being researched and developed.
- **Nuclear fission**
  - Nuclear fission happens when an **atom's nucleus splits into two or more smaller nuclei,** liberating energy.
- **Nuclear fusion**
  - It occurs when **two light atomic nuclei combine** to form a **heavier nucleus,** releasing a tremendous amount of energy in the process.

IGNITE YOUR MIND

Nuclear Nightmare or Clean Dream?: Nuclear power is a double-edged sword – immense power with immense risk. What are the arguments for and against this two-faced energy source? Is it a nuclear nightmare waiting to happen or a path to clean, abundant power?

Global Distribution of Nuclear Minerals

- **Uranium and thorium** are key components of nuclear energy production, and their distribution and availability have a considerable impact on the worldwide energy landscape.
- Here is a breakdown of their global distribution, top-generating countries, consumption patterns, and countries that lead in nuclear energy generation.

Nuclear Energy in India

- India's nuclear energy sector is an important part of its aim to diversify its energy mix and maintain energy security while pursuing sustainable development objectives.
- **Indian States with Nuclear Mineral Reserves:** India has **modest uranium reserves** and significant thorium reserves. Uranium deposits have been found in several states, including:
  - **Andhra Pradesh:** The **Tummalapalle belt** is known for having one of the largest uranium reserves in the world.
  - **Jharkhand: Jaduguda mines** were the first to be developed for uranium mining.
  - **Meghalaya: Domiasiat in West Khasi Hills** is known for uranium deposits.
  - **Telangana: Nalgonda district** has significant uranium reserves.
  - **Rajasthan:** Near **Sikar,** uranium deposits have been identified.
- **Thorium**, which is seen as a future fuel for its abundant reserves along the monazite-rich sands of the coastal regions, is primarily found in:
  - **Kerala:** The coastal **monazite sands of Kerala** have high concentrations of thorium.
  - **Tamil Nadu:** The beaches near **Kanyakumari** have significant thorium deposits.
  - **Odisha:** The coastal areas are rich in **monazite sands** containing thorium.
- **Uranium Imports**
  - India imports a significant portion of its uranium to fuel its nuclear reactors due to **limited domestic production** and the growing demand for nuclear energy.
  - The country has signed uranium import deals with several countries, including **Russia, Kazakhstan, Canada, and Australia,** to secure a steady supply of uranium for its nuclear power plants.
- **Nuclear Energy Production**
  - India has **22 operational nuclear reactors across 7 nuclear power plants,** with a total installed capacity of over **6,780 MW.**
  - The nuclear power plants are located in states such as **Tamil Nadu (Kudankulam Nuclear Power Plant), Maharashtra (Tarapur Nuclear Power Plant), and Rajasthan (Rajasthan Atomic Power Station),** among others.

Nuclear Energy in India: Importance and Challenges

- **Importance of Nuclear Energy in India**
  - **Low Carbon Emissions:** Nuclear power is a **low-carbon energy source,** making it vital for India's efforts to combat climate change and reduce its greenhouse gas emissions.
  - **Energy Security:** By diversifying its energy mix and reducing dependence on imported **fossil fuels, nuclear energy** enhances India's energy security.
  - **High Energy Density:** Nuclear energy has a **high energy density** compared to other renewable sources, meaning it can produce a large amount of electricity from a small amount of fuel, making it suitable for meeting base-load electricity demand.
  - **Long-term viability:** With advancements in nuclear technology, **including breeder reactors and thorium fuel cycles,** India has the potential to utilise its abundant thorium reserves, offering a long-term energy solution.

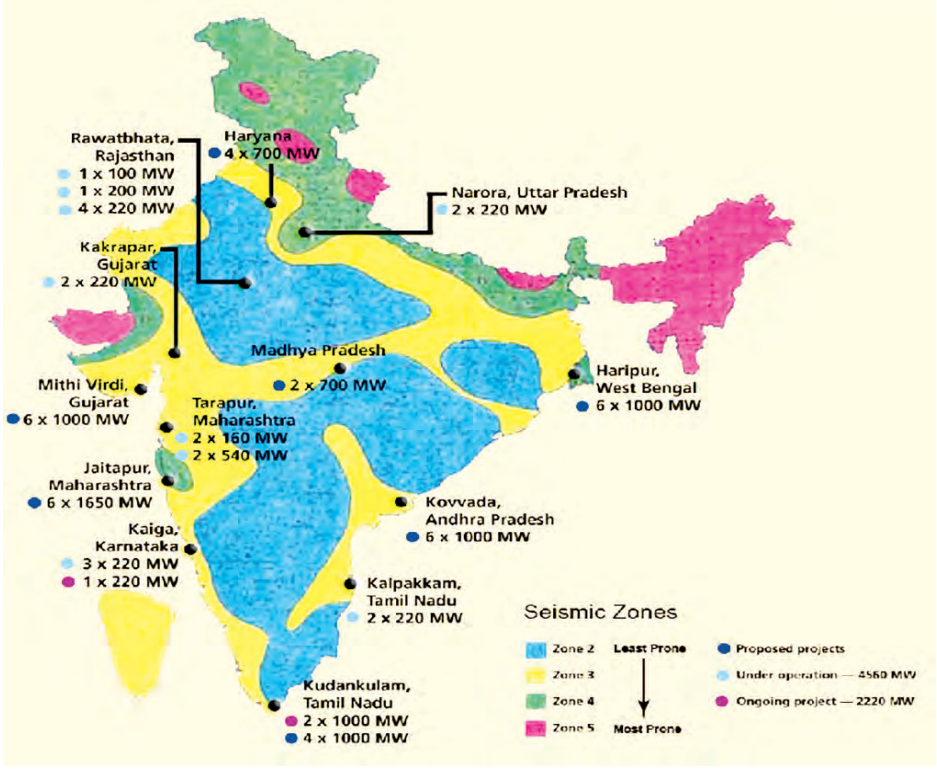


Fig. 4.11: Nuclear Power Plants in India

❑ **Challenges Facing Nuclear Energy in India**

- **High Initial Costs:** The construction of nuclear power plants requires significant capital investment, making it more expensive initially compared to other energy sources.
- **Public Perception and Safety Concerns:** Incidents like the **Fukushima disaster** have raised public concerns about nuclear safety. Ensuring the safety of nuclear installations and gaining public trust remains a challenge.
- **Waste Management:** Managing radioactive **waste safely and sustainably** is a critical issue. Finding long-term waste disposal solutions that are environmentally sound and publicly acceptable is challenging.
- **Regulatory and Policy Framework:** Developing a comprehensive **regulatory and policy** framework that supports the expansion of nuclear energy while ensuring safety and environmental protection is essential.
- **Limited Domestic Uranium Reserves:** India's **limited domestic uranium reserves** necessitate the import of uranium, affecting the cost and sustainability of nuclear power.

Small Modular Reactors (SMRs)

They are an emerging nuclear power technology characterized by their smaller size and modular design, allowing for a capacity of up to 300 MW(e) per unit.

❑ Unlike traditional nuclear reactors, SMRs can be manufactured in a central facility and transported to their installation site, offering advantages in terms of construction time, cost, and flexibility.

❑ Their design incorporates advanced safety features, including passive safety systems, enhancing their safety profile.

❑ SMRs are versatile, capable of being used for electricity generation, desalination, district heating, and industrial processes.

❑ They present a scalable, potentially more cost-effective solution for nuclear energy generation, suitable for a wide range of applications and locations, including remote or off-grid areas.

❑ The International Atomic Energy Agency (IAEA) supports the development and deployment of SMRs, recognizing their potential to contribute to global energy security and sustainability goals.

❑ **Future Plans and Government Schemes:**

- India has ambitious plans to increase its nuclear power capacity as part of its energy diversification strategy.
- The government aims to reach a nuclear power capacity of **22480 MW by 2031-32.**
- **Fast Breeder Reactor Program:** India is focusing on fast breeder reactors that use thorium as fuel, leveraging its vast thorium reserves.
- **International Cooperation:** India is expanding its international partnerships for technology exchange, fuel supply agreements, and support for its domestic nuclear power programme.
- **Indigenous Development:** The government is promoting the development of indigenous reactor technologies, such as the **Advanced Heavy Water Reactor (AHWR),** designed to use thorium as fuel.

The way forward for India's nuclear program includes

- **Strategic Expansion:** Increasing nuclear energy capacity to address the **growing energy demand** and support environmental sustainability.
- **Advanced Technologies:** Focusing on the development of **thorium-based reactors** to utilise India's significant thorium reserves and position the country as a leader in innovative nuclear technology.
- **International Collaborations:** Strengthening partnerships for technology exchange and **securing fuel supply agreements** to enhance the nuclear program's global integration and reliability.
- **Regulatory Framework:** Enhancing safety and security standards through a robust regulatory framework ensures the highest levels of nuclear safety.
- **Public Engagement:** Building public trust and support for **nuclear energy through transparent communication** and engagement, highlighting the benefits and safety of nuclear power.

IGNITE YOUR MIND

Energy Inequality: Have-Nots and Power Plays: Some regions bask in energy abundance, while others struggle in darkness. Can we bridge this gap and ensure everyone has access to the power they need to thrive?

UNCONVENTIONAL NATURAL GAS SOURCES

The exploration and exploitation of unconventional gas resources, including coalbed methane (CBM), Shale Gas, and Gas Hydrates, represent significant steps towards diversifying India's energy portfolio and enhancing energy security.

Coalbed Methane (CBM)

❑ Coalbed Methane, **a form of natural gas** trapped within coal seams, plays a pivotal role as an emerging source of energy.

- It primarily exists as **free gas** in the joints and fractures of coal seams and is adsorbed on the surface of internal micropores.
- Accessing this gas involves drilling into the seams and injecting water to displace the gas.
- The low concentration of heavier hydrocarbons like **propane or butane** in CBM makes it a particularly distinctive energy source that is also safer and cleaner.
- However, its presence in coal mines has been associated with significant **safety risks,** including fire accidents, due to its propensity for spontaneous combustion.

Coalbed Methane in India

- India, with its vast coal reserves, presents significant potential for CBM extraction.
- Despite the current practice of releasing methane into the atmosphere in many coal mines, production is underway in regions such as **Jharia, Raniganj, and Sohagpur.**
- The country boasts an estimated CBM reserve of **2,600 billion cubic metres,** with coal production exceeding **778.19 million tonnes** in the fiscal year **2022–23.** Efforts are ongoing to increase this production to over one billion tonnes by **2025–26.**

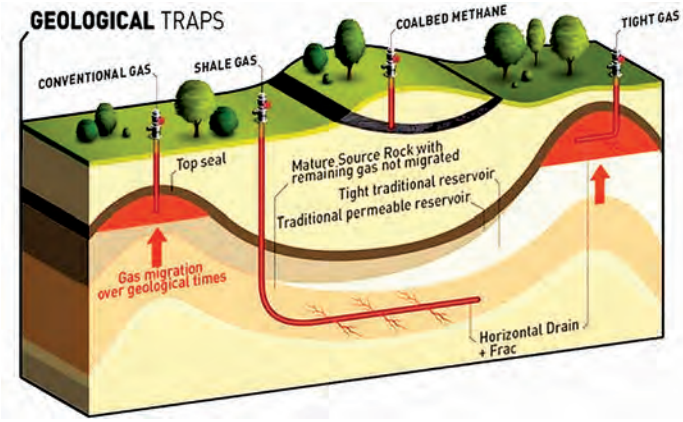


Fig. 4.12: Extraction of Coal Bed Methane

- **Challenges in CBM Exploration and Extraction in India**
  - **Private Exploration Limitations:** Private entities face restrictions in exploring unconventional gas resources.
  - **Jurisdictional Challenges:** Bureaucratic hurdles arise from the division of responsibilities between the Ministry of Petroleum & Natural Gas and the Ministry of Coal.
  - **Extraction Restrictions:** Regulations prevent **simultaneous extraction of gas from coal** seams within the same block.
  - **Technological Barriers:** The need for advanced technologies poses challenges, especially for public sector entities.
  - **Private Sector Constraints:** Legal frameworks and low gas prices hinder private sector involvement.
- **Addressing the Challenges**
  - **Unified Regulatory Framework:** Develop a comprehensive regulatory framework that clearly delineates the roles of the **Ministry of Petroleum & Natural Gas and the Ministry of Coal, reducing bureaucratic hurdles.**
  - **Liberalise Exploration Rights:** Amend regulations to allow more freedom for private entities to explore **unconventional gas resources,** including CBM.
  - **Revise Extraction Restrictions:** Modify regulations to enable simultaneous extraction of gas from coal seams within the same block, optimising resource use.
  - **Adopt Advanced Technologies:** Encourage the adoption of cutting-edge exploration and extraction technologies through public-private partnerships and international collaborations.
  - **Financial Incentives and Support:** Introduce financial incentives such as tax breaks, subsidies, or preferential pricing for CBM to make projects more economically viable.
  - **Legal and Policy Certainty for Private Sector:** Provide a stable legal and policy environment to attract private investments in the CBM sector.
  - **Competitive Pricing Mechanism for CBM:** Implement a competitive pricing mechanism for CBM to ensure it is economically attractive for exploration and extraction.
- **Government Initiatives**
  - **Hydrocarbon Exploration and Licencing Policy (HELP):** This policy **simplifies** the licencing process and offers marketing and pricing freedom for unconventional hydrocarbon resources, including CBM.
  - **Coal Mine Methane (CMM) Development:** Aimed at capturing methane from coal mines to reduce emissions and utilise it as an energy source, this project supports the sustainable use of coal resources.
  - **National Gas Grid Expansion:** The government is expanding the **national gas grid** to enhance the transportation and distribution infrastructure for natural gas, including CBM, across the country.
  - **Policy for Early Monetization of Coal Bed Methane:** This policy facilitates the early monetization of CBM by allowing contractors to sell the gas in domestic markets at arm's length prices.
  - **CBM Marketing and Pricing Freedom:** The government has granted marketing and pricing freedom for CBM, enabling producers to sell CBM at market-determined prices.

Shale Gas

- Shale gas is a form of natural gas (mostly methane) found underground in shale rock.
- Unlike sandstone, shale has **low permeability,** making extraction challenging and costly.
- Shale gas extraction, requiring **horizontal drilling and hydraulic fracturing (fracking),** has been a focus of energy production efforts.
- **Hydraulic Fracturing (Fracking)**
  - The process of fracking, which is necessary for the extraction of shale gas, involves **injecting high-pressure fluid** into rock to break it up with the help of additives like **guar gum,** which increase water viscosity.
  - This process, however, raises environmental concerns, including water demand, potential groundwater contamination, and methane emissions.

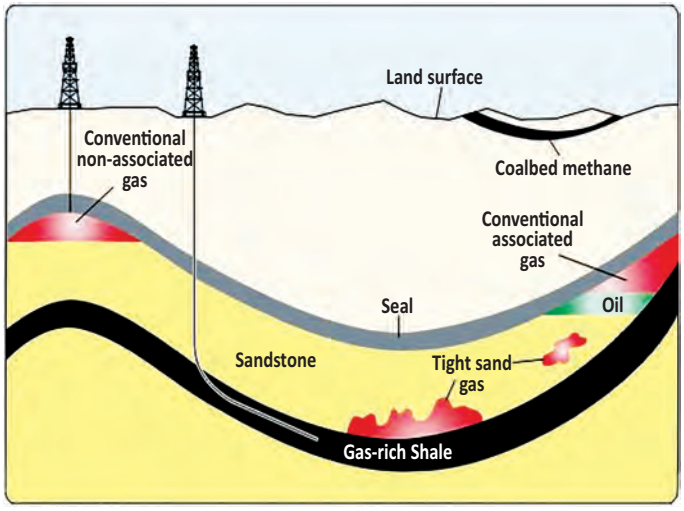


Fig. 4.13: Extraction of Shale Gas

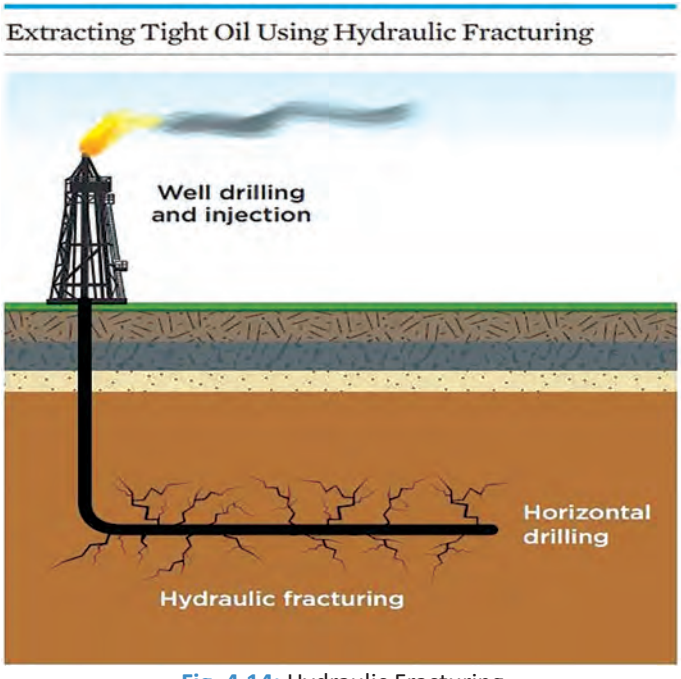


Fig. 4.14: Hydraulic Fracturing

Comparison of Shale Gas and Crude Oil		
Dimension	**Shale Gas**	**Crude Oil**
Definition	❑ Natural gas found trapped within shale formations.	❑ Liquid petroleum extracted from the ground.
Formation	Forms from the burial of mud, silt, and organic matter over millions of years under high pressure and temperature.	Forms from ancient biomass (like plankton and algae) buried under sedimentary rock, transformed by heat and pressure over millions of years.
Extraction	It is extracted through hydraulic fracturing (fracking) where water, sand, and chemicals are injected into the rock to release the gas.	Extracted through drilling wells that tap into underground reservoirs of liquid petroleum.
Usage	Primarily used for heating, electricity generation, and as a feedstock for chemicals.	Refined into various products like gasoline, diesel, jet fuel, heating oil, and used as feedstock in petrochemicals.
Environmental Impact	Concerns include water usage, chemical contamination, and induced seismicity from fracking.	Concerns include oil spills, greenhouse gas emissions from combustion, and landscape disruption from drilling operations.
Location	Significant reserves in the United States, Canada, China, and Argentina.	Found worldwide, with major reserves in the Middle East, Russia, Canada, and the United States.

- **Shale Oil Exploration Prospects in India**
  - India is thought to possess substantial reserves of shale oil and gas, capable of potentially fulfilling the country's energy requirements for a quarter of century.
  - With few viable oil flow quantities identified, India's shale oil and gas exploration, under the leadership of ONGC, has not yet been commercially successful.
  - Despite this, policy guidelines have been established for exploration, highlighting the ongoing interest in tapping into shale resources.

❑ **Availability of Shale Oil and Gas in India:**

- India is believed to possess substantial reserves of shale oil and gas, primarily situated in the Cambay, Krishna-Godavari, and Cauvery basins.
- The extraction of shale oil and gas necessitates advanced drilling technologies, which are costly and intricate to deploy. The economic feasibility of shale gas and oil extraction in India mainly hinges on the accessibility of cost-effective and efficient extraction technologies.
- India boasts significant reserves of coal bed methane [CBM], which can be extracted using similar methods as shale gas. India possesses the fifth-largest CBM reserves globally, with an estimated reserve of 2,700 billion cubic metres.

❑ **Problems Associated With Shale Gas Exploitation**

- **Massive Water Demand for Fracking:** Shale oil extraction, particularly **hydraulic fracturing (fracking),** requires substantial volumes of water, posing concerns about water scarcity and competition for resources.
- **Groundwater Contamination:** The fracking process carries the **risk of contaminating groundwater** due to the potential migration of chemicals and hydrocarbons from shale formations into underground water sources.
- **Flowback Water Recycling and Leakage:** Handling flowback water, which often contains **methane** and various contaminants, presents challenges in terms of recycling and preventing leakage, as improper management can lead to environmental issues.
- **Excessive Methane Emissions:** Shale oil extraction is associated with excessive methane emissions, a potent **greenhouse gas**, contributing to environmental concerns and climate change.
- **Inadequate Handling of Drill Cuttings:** Proper disposal and management of drill cuttings, the solid materials generated during drilling, are crucial to prevent soil and groundwater contamination.
- **Pollution During Extraction:** Shale oil extraction, when compared to conventional sources, can result in **increased pollution,** although the extent varies depending on whether operators take measures to reduce wasteful emissions and minimise environmental damage.

❑ **The way forward for shale gas development in India involves:**

- **Policy Reform:** Implementing clear and supportive policies to encourage exploration and production of shale gas.
- **Technological Advancements:** Adopting advanced drilling and extraction technologies to efficiently tap shale gas reserves.
- **Environmental Safeguards:** Establishing robust environmental regulations to mitigate the impact of shale gas extraction on water resources and ecosystems.
- **Stakeholder Engagement:** Engaging local communities and stakeholders to address concerns and ensure transparent operations.
- **International Collaboration:** Partnering with countries experienced in shale gas production to gain technical expertise and best practices.

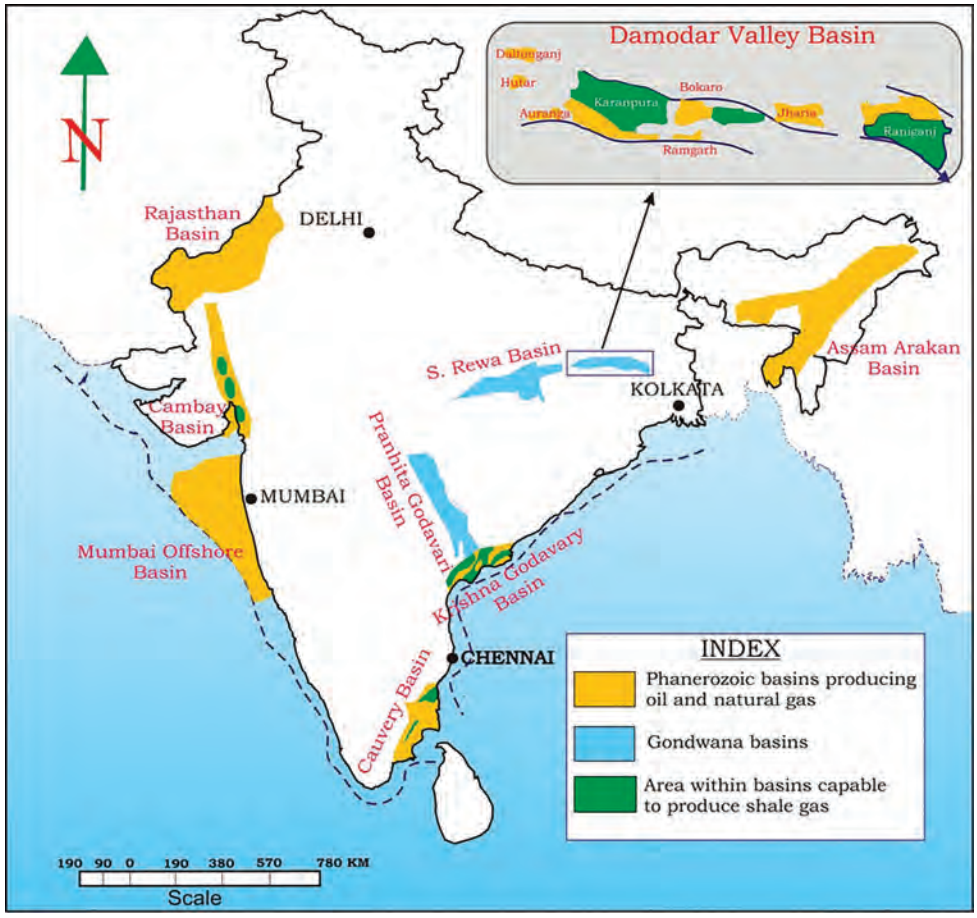


Fig. 4.15: Shale Gas Reserves in India

Gas Hydrates

- Gas hydrates are **crystalline structures of methane and water.** They represent a significant potential energy source, especially in India's offshore regions.
- Estimated at **1,894 trillion cubic meters,** these resources could dramatically impact India's energy security and industrial growth.
- **Global Regions with Gas Hydrate Potential**
  - **North America:** Significant deposits in the Gulf of Mexico and permafrost regions of Alaska.
  - **Asia:** Large reserves in the marine sediments of the Sea of Japan, East China Sea, and off the coasts of India and South Korea.
  - **South America:** Deposits along the Pacific continental margins, particularly off the coasts of Chile and Peru.
  - **Arctic Region:** Extensive resources in the permafrost areas of Canada, Russia, and the Siberian continental shelf.
  - **Antarctica:** Potential deposits in the marine sediments around the continent.
- **Gas Hydrate Regions in India**
  - **Krishna-Godavari Basin:** Extensive gas hydrate deposits have been discovered in the Krishna-Godavari Basin, off the eastern coast of India.

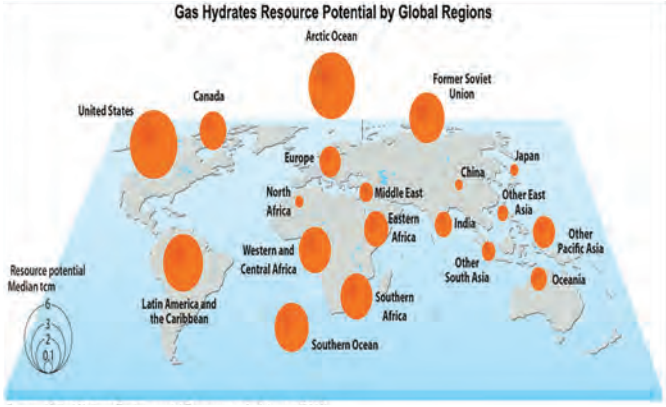


Fig. 4.16(a): Gas Hydrates Resource potential by Global Regions

  - **Mahanadi Basin:** Similar potential has been identified in the Mahanadi Basin, northeast of the Krishna-Godavari Basin.
  - **Andaman Sea:** The Andaman offshore region is another area where India has discovered promising gas hydrate deposits.
  - **Kerala-Konkan Basin:** Initial explorations indicate the presence of gas hydrates off the western coast of India in the Kerala-Konkan Basin.
- **Significance of Gas Hydrates**
  - **Abundant Resources:** Offering a vast energy source, potentially exceeding petroleum reserves.
  - **Future Energy Resource:** Could meet substantial energy demands, enhancing national energy security.
  - **Environmental Benefits:** Safe extraction methods could reduce methane emissions and environmental impacts.

Challenges in Gas Hydrate Extraction

- **Geophysical Challenges:** Include potential seabed weakening and sand migration.
- **Environmental Challenges:** Risk to marine ecosystems and potential contribution to climate change.
- **Economical and Technological Challenges:** High costs and the need for specialised drilling and extraction technologies.

- **Government Measures for Gas Hydrate Exploration**
  - **The National Gas Hydrate Programme (NGHP):** It was launched in 1997 to spearhead research and exploration efforts.
  - **Gas Hydrate Research and Technology Centre (GHRTC):** Established by **ONGC** to advance technology and understanding of gas hydrates.
  - **International Collaboration:** Partnerships with countries like the **United States, Canada, and Japan** to enhance research capabilities.
  - **GAIL and IIT Madras Initiatives:** The focus is on methane recovery from hydrates with CO_2 sequestration in the **Krishna-Godavari basin.**

The table below provides an overview of unconventional natural gas sources, which are becoming increasingly essential in meeting rising energy demand. The table lists the five primary forms of unconventional natural gas: shale gas, tight gas sandstone, coal bed methane, methane hydrates, and biogenic gas.

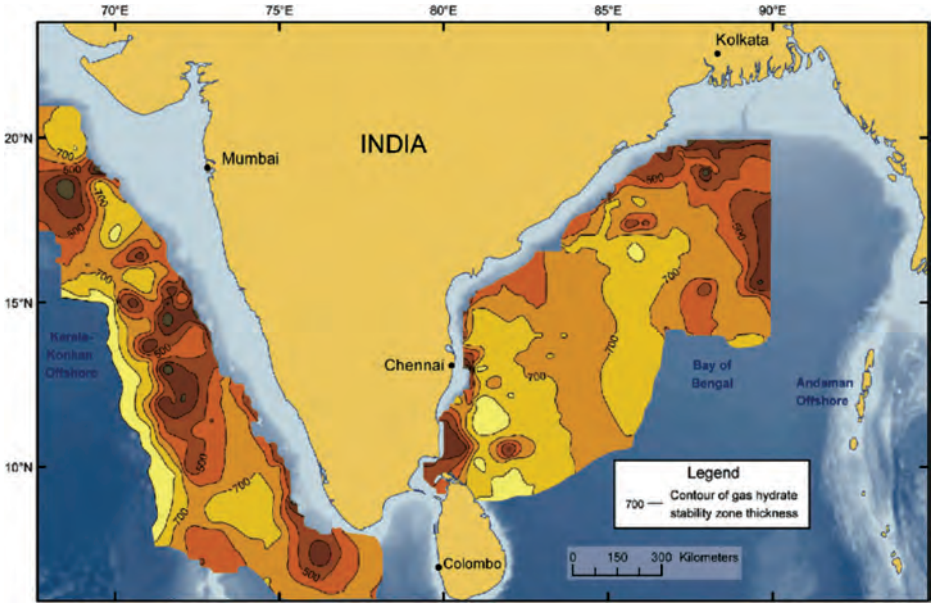


Fig. 4.16(b): Methane Hydrate Basins in India

Unconventional Gas Source	Description
Shale Gas	❑ Shale gas is trapped within organic-rich shale formations. ❑ It is extracted using horizontal drilling and hydraulic fracturing techniques. ❑ Major locations in the U.S. include Texas, Louisiana, Arkansas, and Pennsylvania, with notable examples being the Marcellus and Barnett Shales.
Tight Gas Sandstone	❑ Tight gas is found in sandstone or limestone formations that have high porosity but low permeability. ❑ The extraction process involves horizontal drilling and hydraulic fracturing. ❑ Tight gas is commonly found in regions similar to those of shale gas.
Coal Bed Methane	❑ Coal bed methane is found within coal seams, which was traditionally considered a hazard in mining. ❑ It is extracted using drilling and fracturing techniques akin to those used for shale gas. ❑ Significant deposits are located in Colorado, New Mexico, and Wyoming, such as those in the San Juan Basin.
Methane Hydrates	❑ Methane hydrates consist of methane molecules trapped within a lattice of water molecules, appearing as a solid similar to ice. ❑ They are found in arctic regions and beneath the ocean floor. ❑ The extraction of methane hydrates is currently technically challenging and not economically feasible.
Biogenic Gas	❑ Bacteria use the decomposition of organic matter in an oxygen-free environment to produce biogenic gas. ❑ This type of methane is generated through the anaerobic digestion of organic wastes, including livestock manure, food waste, and sewage. ❑ In the U.S., farm-based digesters are particularly prevalent in the Midwest, and globally, biogas production is a well-established technology in landfills and waste treatment facilities.

NON-CONVENTIONAL SOURCES OF ENERGY

- **Non-conventional energy** sources are alternative, renewable energy sources that are thought to be more sustainable and environmentally benign than conventional fossil fuels.
- These include solar, wind, hydroelectric, geothermal, and biomass energy.
- Unlike traditional sources, non-conventional energy seeks to offer **cleaner power** with reduced greenhouse gas emissions by utilising natural processes and phenomena.
- **Technological improvements, lower costs, and increased awareness of environmental implications** are driving their expanding use, signalling a watershed moment in the global transition to more sustainable energy alternatives.

IGNITE YOUR MIND

Renewable Revolution: Hype or Hope?: Wind, solar, and biofuels dance on the horizon, promising a greener future. But are these just fleeting mirages, or can they truly power our world? Unravel the challenges and potential of these renewable warriors.

Hydro-Electric Power

- Hydropower uses the energy of **flowing water,** typically from **rivers or streams,** to generate electricity.
- Hydropower is a **form of renewable energy generation**. Hydropower from water mills has been used for irrigation and the operation of mechanical devices like gristmills, sawmills, textile mills, trip hammers, dock cranes, domestic lifts, and ore mills since ancient times.

Working Principle

- Hydroelectric power plants typically consist of a water reservoir, a gate or valve for controlling water flow, and an outlet where water is discharged after flowing downward.
- Prior to overflowing or descending down a hill, water accumulates potential energy.
- As water descends, potential energy transforms into kinetic energy.
- The kinetic energy of water is harnessed to produce electricity by spinning turbine blades, which then distributes power to consumers.

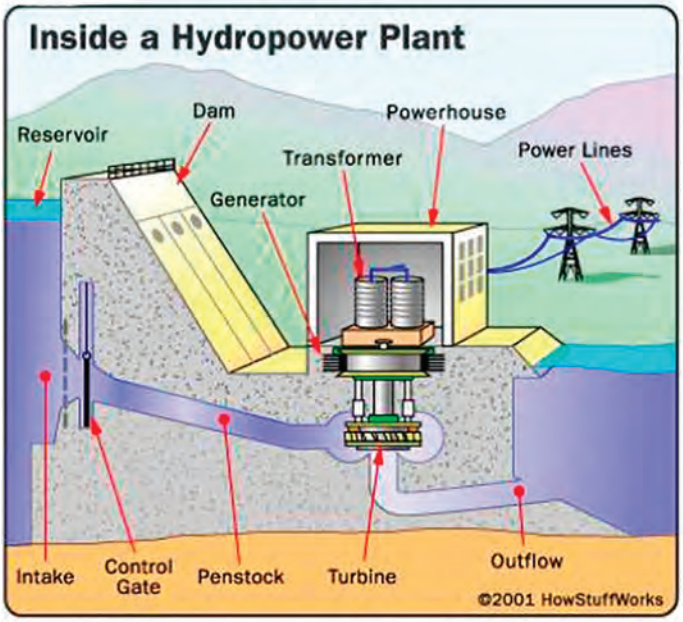


Fig. 4.17: Working Mechanism of Hydroelectric Power Plant

Global Scenario of Hydropower Generation

- Hydropower makes a substantial contribution to the world's **renewable energy supply** by providing a clean and reliable source of electricity.
- According to the latest data, the world's total Hydropower installed capacity reached 1,330 gigawatts (GW) in 2020 as generation hit a record 4,370 terawatt hours (TWh).
- Hydropower is the world's greatest source of renewable energy, accounting for over **16%** of total electricity generation.
- The worldwide hydropower sector is booming, with emerging economies and developing countries boosting hydropower capacity to satisfy rising energy demands and climate targets.
- The **International Hydropower Association (IHA)** reports on current projects and proposed expansions that will boost worldwide hydropower capacity in the next few years.

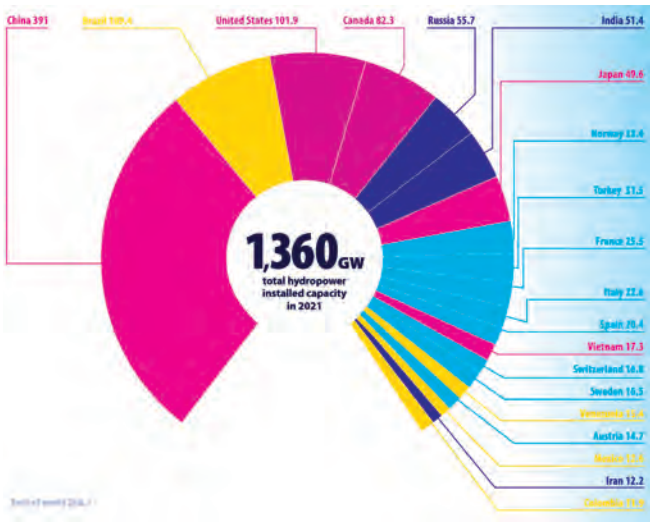


Fig. 4.18: Hydropower installed capacity in 2021 (in GW)

Top Global Hydroelectric Producing Countries

- **China:** Leading the world in hydroelectric production, China has capitalised on its vast river systems, most notably the **Three Gorges Dam,** the largest power station in the world by installed capacity. China's hydropower capacity **exceeds 350 GW,** making it a cornerstone of the country's renewable energy strategy.
- **Brazil:** Brazil utilises its **abundant river resources,** including the **Amazon River** basin, to generate a significant portion of its electricity from hydropower. With **over 100 GW** of installed capacity, hydropower accounts for more than 60% of Brazil's total electricity generation.
- **Canada:** Canada is one of the world's largest producers of hydropower, with an installed capacity of approximately **81 GW.** The country's vast and diverse geography offers ample opportunities for hydropower development, particularly in **Quebec, British Columbia, and Ontario.**
- **The United States:** The U.S. has a long history of hydropower use, with an installed capacity of **around 101 GW.** The **Grand Coulee Dam** on the **Columbia River** is one of the largest in the country. Hydropower remains a key component of the U.S. renewable energy portfolio.
- **Russia:** Russia's vast territory and abundant water resources contribute to its significant hydropower capacity, estimated at **around 50 GW.** The **Sayano-Shushenskaya Dam** is among its largest hydroelectric power stations.

Future projections

- According to the **International Energy Agency (IEA)'s flagship Net Zero by 2050 report,** the world will need 2,600 GW of hydropower capacity by 2050 to help limit global temperature rise to well below 1.5 degrees Celsius.
- Such development would help generate **600,000 skilled jobs** over the next decade, with an estimated investment of **$1.7 trillion.**
- According to the **International Energy Agency (IEA),** global investment in hydropower exceeded **$50 billion in 2019,** falling well short of the predicted **$100 billion per year** required to satisfy the organization's Sustainable Development Scenario.

Hydropower in India

- Hydropower production in India is critical to the country's **energy landscape,** utilising the power of its vast and **diverse river systems** to generate clean and sustainable electricity.
- As one of the country's **oldest energy sources,** hydropower plays an important role in India's goal of attaining sustainable development and energy security, combining its geographical advantages and technological skills to meet a considerable amount of its electricity demand.

Fig. 4.19: Hydro Power Plants in India

- The **Ministry of Power** is responsible for **large hydropower** projects in India. The **Ministry of New and Renewable Energy (MNRE)** is responsible for **small hydropower** projects up to **25 MW.**
- **Current Capacity and Growth**
  - **Installed Capacity:** As of **March 2023,** India's installed hydropower capacity stood at **42,104 MW**, making up **11.4%** of the country's total installed generation capacity.
- India's geographical diversity, especially in the Himalayan states and the northeastern region, presents a significant opportunity for hydropower development. These areas are characterised by abundant rainfall and steep gradients, creating ideal conditions for generating hydroelectric power.

- **Himalayan States:** The Himalayan states, including **Himachal Pradesh, Uttarakhand, and Jammu & Kashmir,** are endowed with extensive hydropower potential. The rugged terrain, coupled with numerous rivers and their tributaries, makes these states prime locations for hydropower projects.
- **Northeastern Region:** Similarly, northeastern states such as **Arunachal Pradesh, Sikkim, and Assam** boast rich hydropower resources. The Brahmaputra River and its tributaries flow through this region, offering substantial untapped potential for hydropower generation.
- **Geographical Spread and Major Projects:** Hydropower projects in India are predominantly located in the northern and northeastern regions, taking advantage of the Himalayan rivers' flow. Key projects like the **Bhakra Nangal Dam, Tehri Dam, and Nathpa Jhakri Dam** exemplify how India leverages its geographical features for hydropower development, contributing significantly to the country's renewable energy portfolio.

❑ **Factors Influencing Development of Hydropower Projects in India**

- **Government Policies:** India's government supports hydropower through various **policies and initiatives,** recognising its role in ensuring energy security and reducing reliance on fossil fuels.
- **Geographical Advantage:** The country's diverse topography, especially in the **Himalayas,** offers ideal conditions for hydropower.
- **Environmental Considerations:** Hydropower contributes to India's sustainable energy goals by providing a **low-carbon alternative to fossil fuels.**

❑ **Challenges**

- Hydropower development in India faces challenges, including **environmental and social impacts, sedimentation in reservoirs, regulatory complexities,** and the **logistical and financial hurdles** of constructing in difficult terrains.

❑ **Advantages of Hydroelectricity**

- **Renewable Energy Production:** Hydroelectric power is generated by harnessing the **natural water cycle,** making it a perpetually renewable resource. Unlike fossil fuels, water is **not consumed** during power generation, ensuring a sustainable energy source that can last as long as the water cycle continues.
- **Low Operational Costs:** Once a hydroelectric plant is constructed, **it requires relatively low maintenance and operational costs** compared to fossil fuel-based power plants. The absence of fuel costs in hydroelectricity significantly reduces the cost of electricity generation over the plant's lifespan.
- **Quick Response to Demand:** Hydroelectric power plants can quickly adjust their output **to match demand fluctuations,** making them an excellent source for meeting peak electricity demands. Pumped storage plants, in particular, can store energy and release it when needed, enhancing grid stability and reliability.
- **Carbon Emissions Reduction:** By displacing power generation from **fossil fuels,** hydroelectricity significantly reduces greenhouse gas emissions. This contributes to India's efforts to combat climate change and achieve its carbon reduction targets.

IGNITE YOUR MIND

Hydropower Heros & Villains: Dams provide light, but also drown communities and ecosystems. Are they benevolent giants or environmental villains? Can we find a middle ground where the river's rhythm and human needs flow in harmony?

❑ **Schemes/Policies for Hydropower Development**

- India's aims to revitalise the hydroelectric sector, particularly in the **North and North Eastern Regions,** and address its reduced share in the energy mix. Despite hydroelectric stations contributing **only 25%** of the total installed capacity, the policy targets increasing this share by promoting capacity addition, accelerating hydroelectric potential exploitation, and encouraging both public and private investments in the sector.
- **Key Objectives and Instruments:**
  - **Adequate Funding:** Increase budget allocations and supplementary funding through the Power Finance Corporation.
  - **Basin-wise Development:** Delegate development tasks to Central Hydel Public Sector Corporations based on river basins.
  - **Survey and Investigation Support:** Provide financial support for essential surveys and investigations.
  - **Power Development Fund:** Create a fund financed by a levy on electricity consumption to support state and central hydroelectric projects.
  - **Differential Pricing for Peaking Power:** Promote investments in projects offering cost-effective peaking power.
  - **Addressing Geological Risks:** Establish mechanisms to mitigate geological risks in hydro projects.

- **Joint Ventures and Simplified Procedures:** Encourage joint ventures and simplify the transfer of clearances to streamline project approvals.
- **Enhanced Clearance Limits:** Raise the ceiling for techno-economic clearances by the Central Electricity Authority for faster project initiation.

This policy reflects India's commitment to enhancing its hydroelectric capacity as part of a broader strategy to diversify its energy sources, promote renewable energy, and ensure long-term sustainability and energy security.

Solar Energy

- Solar energy, a pivotal component of India's renewable energy strategy, harnesses the **sun's power to generate electricity or heat.**
- This clean, abundant, and sustainable source is instrumental in powering diverse applications, from residential and commercial setups to large-scale utility plants.

IGNITE YOUR MIND

Sun-Kissed Cities: Imagine a city powered entirely by solar energy. What technologies and lifestyle changes would be needed?

World Solar Energy Overview

Leading nations have made significant contributions to the global solar energy landscape, each of which has a crucial role to play in utilising the sun's power to meet their energy needs and environmental objectives.

Photovoltaic (PV) Electricity

- It involves converting sunlight directly into electricity using solar panels made of semiconductor materials.
- The process is based on the photovoltaic effect, where light energy (photons) knocks electrons free from atoms within the solar panel, generating a flow of electricity.
- PV systems can range from small, rooftop installations for individual homes to large, utility-scale solar farms. They offer a clean, renewable source of energy, reducing reliance on fossil fuels and contributing to environmental sustainability.
- PV electricity is versatile and scalable it has seen significant growth worldwide due to falling costs, technological advancements, and increasing global commitment to reducing carbon emissions.

As of 2022, the forefront of solar energy production is characterised by the following countries:

- **China:** Dominating the global scene, **China is the largest producer of solar-powered electricity.** The country's extensive investment in solar technology and infrastructure underscores its commitment to leading the renewable energy transition.
- **The United States:** The United States, which is the **world's second-largest producer of solar energy,** has made significant progress in the field thanks to progressive policies and technological advancements that encourage the growth of solar installations all over the country.
- **Japan:** As a key player in the solar energy sector, Japan contributes significantly to the global solar output. The country's focus on solar energy is part of its broader strategy to diversify its energy sources and reduce its carbon footprint.

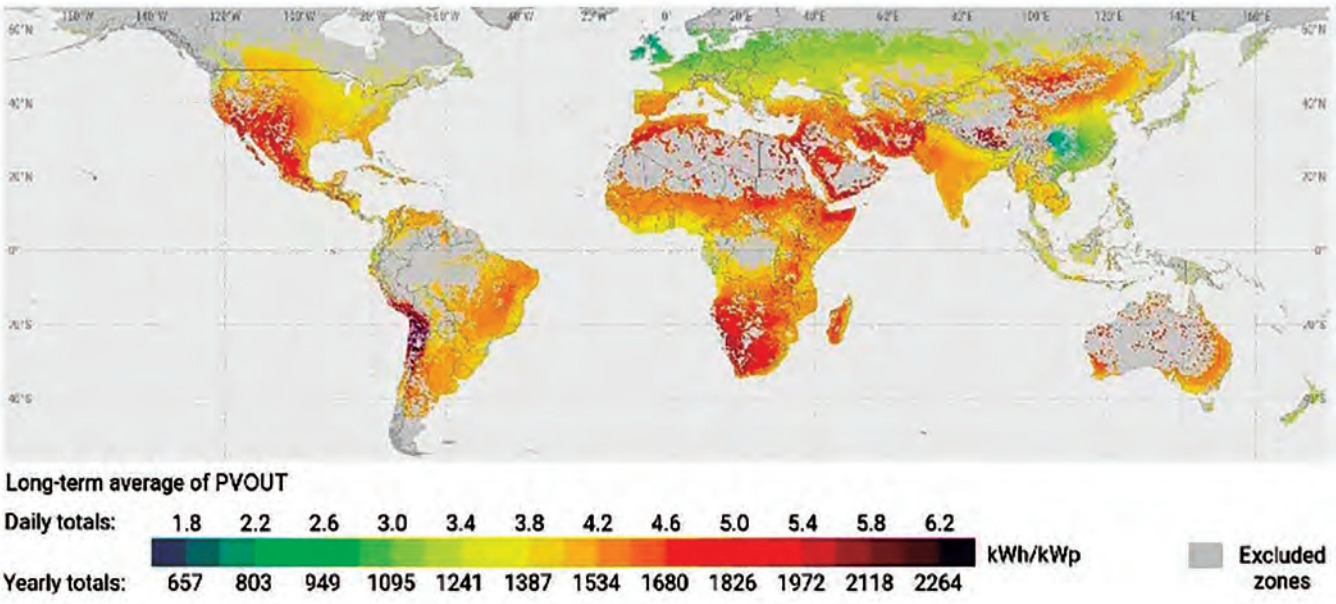


Fig. 4.20: Solar Energy Potential of World

- **Germany:** Germany's leadership in solar energy production is a testament to its early and ongoing commitment to renewable energy. The country has been a pioneer in adopting solar power and integrating it into its national energy mix.
- **India:** Rounding out the top producers, India has emerged as a major solar energy player. With ambitious solar targets and large-scale projects, India is leveraging its abundant sunshine to power its growth sustainably.

Solar Energy Infrastructure

- **Solar Rooftop Systems:** Installed on residential or commercial building rooftops, these systems generate electricity for onsite use and can supply excess power back to the grid.
- **Solar Parks:** Large-scale solar installations developed in collaboration with state governments or private firms contribute significantly to India's solar capacity.

India: Current Capacity and Growth

- **Installed Capacity:** India aims for a solar energy target of 280 GW by 2030, with an installed capacity of 71.61 GWAC as of August 2023. India ranks 5th in solar power capacity globally.
- **Growth Trends:** Solar power has seen consistent growth, becoming a substantial part of India's total renewable energy capacity.

Potential for solar energy in india

- **Desert regions** such as Rajasthan and Kutch, characterised by barren lands and abundant insolation, are deemed optimal for solar energy production.
- The **Himalayan and northeastern regions** exhibit lower potential for solar energy generation owing to their diminished insolation levels and challenging terrain.
- **Coastal states** like Kerala demonstrate moderate potential for solar energy generation due to prolonged monsoon seasons compared to central regions.
- States situated closer to the **tropics**, experiencing high solar insolation, are identified as **hotspots** for solar energy production.
- The **urban rooftop** solar panel initiative harbours considerable potential in **metropolitan cities** and can significantly contribute to India's solar energy objectives.

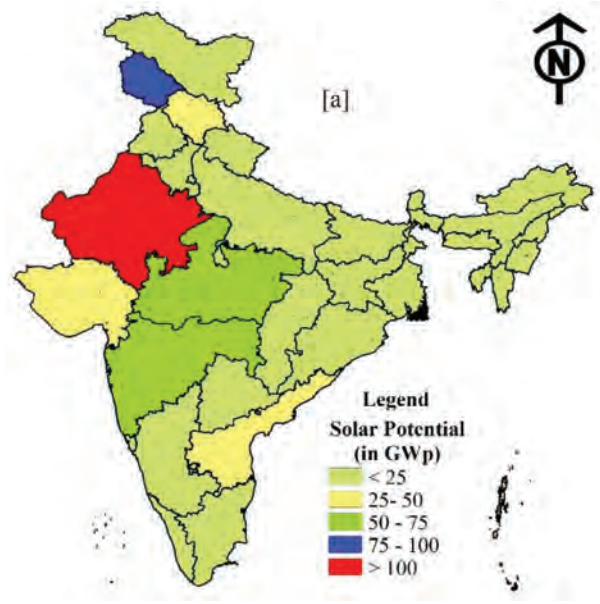


Fig. 4.21: State Wise Solar Energy Potential in India

Areas of Presence

- Solar energy projects are widespread across India, with significant installations in **Rajasthan (17.8 GW), Gujarat (10.13 GW), Karnataka (9.05 GW), Tamil Nadu (6.8 GW), and Maharashtra (4.8 GW).**
- State with potential solar energy in terms of MWp (Megawatt peak): **Rajasthan: 142310 MWp, Jammu & Kashmir: 111050 MWp, Madhya Pradesh: 61660 MWp, Maharashtra: 64320 MWp, Andhra Pradesh: 38440 MWp and Gujarat: 35770 MWp.**
- Noteworthy projects include the **Bhadla Solar Park in Rajasthan and the Pavagada Solar Park in Karnataka.**

Factors Responsible for Growth

- **Government Policies:** Initiatives like the **National Solar Mission and the Suryodaya Yojana** have been pivotal in solar energy promotion.
- **Investment:** The sector has attracted substantial domestic and foreign investments.
- **Technological Advancements:** Innovations have enhanced solar energy's efficiency and cost-effectiveness.
- **Environmental Concerns:** Renewable energy is increasingly recognised for its role in reducing carbon emissions.
- **Economic viability:** The cost of solar panels and related technologies has decreased, making solar energy more accessible.

Solar Energy Challenges in India

- **Land Acquisition:** Securing land for large-scale solar projects can lead to **conflicts,** particularly in densely populated regions.
- **Intermittency and Storage:** The intermittent nature of solar energy and the **lack of efficient storage** solutions remain significant challenges.

- **High Initial Costs:** Despite reduced costs, the initial investment in solar infrastructure is still considerable.
- **Maintenance and Performance:** Factors like **dust, pollution, and weather conditions** can impact solar panel performance, necessitating regular upkeep.

Steps taken by Government to Promote Solar Energy in India

- **Scheme for Development of Solar Parks and Ultra-Mega Solar Power Projects:** It aims to set up **40,000 MW of solar power capacity** by developing infrastructure like land, roads, power evacuation systems, and water facilities, along with all statutory clearances/approvals to expedite the development of utility-scale solar projects.
- **Central Public Sector Undertaking (CPSU) Scheme Phase-II:** It focuses on establishing grid-connected **Solar Photovoltaic (PV) Power Projects** by government producers using **domestically manufactured solar PV cells and modules.** It includes **Viability Gap Funding (VGF)** support for self-use or use by Government/ Government entities, either directly or through **Distribution Companies (DISCOMs).**
- **Production Linked Incentive Scheme 'National Programme on High Efficiency Solar PV Modules':** Aims to achieve **Giga Watt (GW)** scale manufacturing capacity in **High Efficiency Solar PV modules,** enhancing India's manufacturing capabilities in the solar sector.
- **PM-KUSUM Scheme:** Promotes **small Grid Connected Solar Energy Power Plants,** stand-alone solar-powered agricultural pumps, and **solarisation** of existing grid-connected agricultural pumps. This scheme benefits farmers, States, and DISCOMs by providing cheaper solar power and saving on subsidies for electricity for agriculture consumers.
- **Rooftop Solar Programme Phase II:** Targets **grid-connected solar rooftop power plants** in the residential sector, offering subsidies and performance-linked incentives to DISCOMs for achieving capacity addition in rooftop solar above the baseline.
- **Green Energy Corridors (GEC):** Aims to create an intra-state transmission system for renewable energy projects, providing **Central Financial Assistance (CFA)** to set up transmission infrastructure for evacuating power from Renewable Energy projects in ten States.
- **Pradhan Mantri Suryoday Yojana:** Pradhan Mantri Suryoday Yojana aims to provide rooftop solar power systems to **one crore households** across the country. The central government would provide a **60% subsidy for rooftop solar installations,** an increase from the previous subsidy rate **of 40%.** This initiative specifically targets consumers whose consumption is **less than 300 units,** typically including economically weaker sections of society, to alleviate the financial burden of transitioning to solar energy.
- These initiatives underscore India's strategic approach to enhancing its renewable energy capacity, particularly in solar energy, to meet its ambitious targets and contribute to global sustainability efforts.

Wind Energy

- Wind energy, a cornerstone of renewable power, generates electricity by **harnessing the kinetic energy of the wind through turbines.**
- This clean, renewable energy source is notable for its ability to dramatically reduce carbon emissions, providing a sustainable alternative to fossil fuels.

World Wind Energy Scenario

- The **Global Wind Report 2023** provides a comprehensive overview of the wind energy sector, highlighting significant growth, potential, and the leading countries in wind power production.
- According to the report, 2022 marked the third-best year for new wind capacity, **with 78 GW added globally,** bringing the total installed capacity to **906 GW.**
- This represents a year-on-year growth of **9%.**
- Looking ahead, 2023 is anticipated to be the first year to exceed **100 GW** of new capacity added globally, forecasting a year-on-year growth of **15%.**
- **Top Global Wind Energy Producers**
  - The report identifies the world's top markets for new installations in 2022 as **China, the USA, Brazil, Germany, and Sweden.**
  - These countries collectively accounted for **71% of global installations last year.**
  - However, it's noted that China and the USA, the two largest markets, saw a combined **5% decrease in market share** compared to the previous year, marking the second consecutive year of market share loss for both countries.

The Global Wind Report 2023 underscores the wind sector's dynamic growth and its critical role in the global transition to renewable energy. With substantial new capacity on the horizon, wind energy continues to be a key player in decarbonising the global energy system.

Wind Energy in India

Wind energy is a **critical component** of India's renewable energy plan, leveraging the country's enormous and dynamic wind resources throughout its vast landscape.

- As **one of the world's leading producers of wind energy,** India has embraced this clean, sustainable power source to diversify its energy mix, cut carbon emissions, and meet aggressive renewable energy targets.

Types of Wind Energy Systems in India

- India's wind energy sector encompasses a variety of systems designed to capture wind power:

- **Onshore Wind Farms:** Predominantly found across India, these installations feature **turbines on land,** capitalising on the country's diverse wind patterns.
- **Offshore Wind Farms:** While still in early development stages in India, offshore farms place turbines in **large water bodies, like seas, to** harness stronger wind currents.
- **Small Wind Turbines:** Catering to **localised needs,** especially in remote or rural areas, these smaller turbines provide a decentralised energy solution.

Current Capacity and Growth of Wind Energy in India

- **Installed Capacity:** As of February 2023, India boasts an installed wind power capacity of **42.02 GW,** aiming for a **2030 target of 140 GW.**
- This positions India as the **fourth-largest globally** in wind power capacity.
- **Growth Trends:** India has witnessed substantial growth in wind power capacity, with aggressive future targets reflecting the country's commitment to renewable energy expansion.

Areas of Presence

- **Geographical Spread:** Major wind energy installations are found in states like **Tamil Nadu, Gujarat, Maharashtra, and Karnataka,** which have favourable wind conditions.
- According to 2019 data, the following are the rankings of states in wind production in India: **Tamil Nadu (9075 MW), Gujarat (7855 MW), Maharashtra (4781 MW), Karnataka (4779 MW) and Rajasthan (4292 MW)**
- **Wind Parks:** India has developed several large wind parks. Examples include **Jaisalmer Wind Park (1064 MW), Muppandal Wind Farm (1500 MW), etc.**

Factors Responsible for Growth

- **Government Initiatives:** Supportive policies and incentives under initiatives like the **National Wind-Solar Hybrid Policy** have been pivotal in wind energy's growth.
- **Technological Advancements:** Enhancements in **turbine technology** have led to **greater efficiency and lower costs,** propelling the sector forward.
- **Investment:** The wind sector has attracted substantial investment, bolstering project development and infrastructure.
- **Environmental Goals:** Wind energy plays a vital role in India's strategy to mitigate climate change and reduce reliance on fossil fuels.
- **Economic viability:** The **decreasing** cost of wind energy production has made it an increasingly competitive and attractive option for investors.

Wind Energy Challenges in India

- **Site Constraints:** The optimal locations for wind farms often face **logistical challenges**, including grid connectivity and the transportation of turbine components.
- **Variability of Wind:** The **inherent unpredictability** of wind speeds can affect the consistency and reliability of wind energy generation.
- **Environmental and Social Impact:** The **construction and operation** of wind farms can disrupt local ecosystems and communities, necessitating careful planning and mitigation strategies.
- **Infrastructure and Investment:** Establishing the necessary infrastructure, such as **transmission systems,** requires significant investment and long-term commitment.

Reasons for the limited spatial spread of wind energy

- **Land availability** poses a challenge for wind energy projects as turbines require extensive land, often leading to difficulties in acquisition due to issues related to land ownership, local regulations, and environmental concerns.
- **Transmission infrastructure** presents a bottleneck for wind energy projects, as adequate infrastructure is necessary for transporting electricity from project sites to the grid. However, the existing transmission infrastructure in India is frequently insufficient, resulting in grid congestion and the curtailment of wind power generation.
- **Financing** is a significant hurdle for wind energy projects due to their **high capital costs**, which can make it difficult for developers to secure funding. Additionally, a lack of supportive regulatory frameworks, including feed-in-tariffs and incentives, may deter private investment in wind energy.
- **Political and regulatory challenges** frequently impede the development of wind energy projects in India, characterised by bureaucratic delays, corruption, and a lack of clear policy directives.
- **Environmental concerns** arise from wind projects, such as the impact on bird populations due to turbine blades. For instance, the **Great Indian Bustard**, an endangered bird, has been adversely affected by wind turbines in the Kutch region

Steps taken by Government to Promote Wind Energy in India

The Government of India has implemented several measures and schemes to promote wind energy, recognising its potential to contribute significantly to the country's renewable energy targets. Here are some of the key steps and latest schemes aimed at fostering the development of wind energy in India:

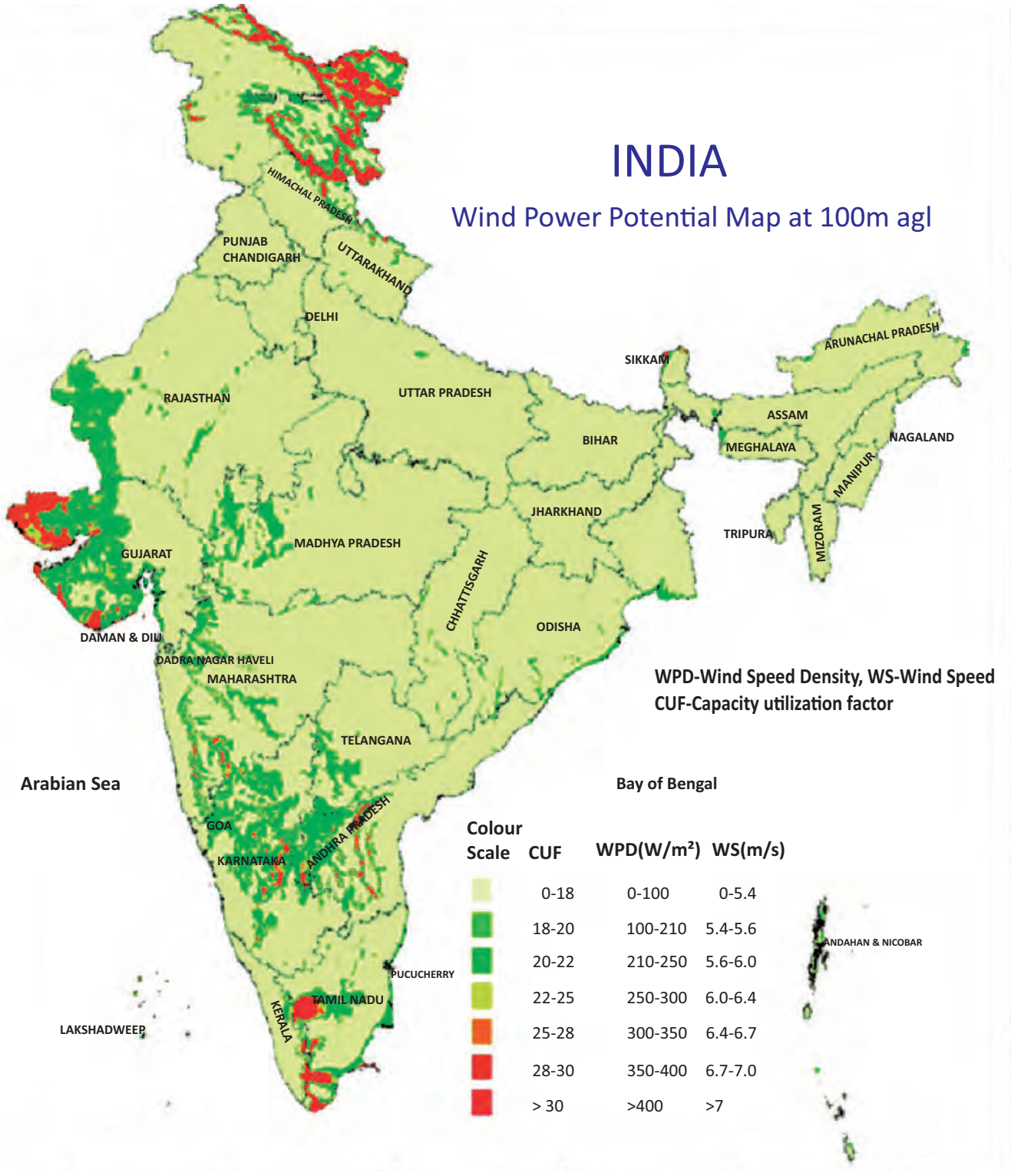


Fig. 4.22: Wind Energy Potential in India

- **Wind-Solar Hybrid Policy:** The **Ministry of New and Renewable Energy (MNRE)** introduced the Wind-Solar Hybrid Policy to maximise the utilisation of wind and solar resources by promoting the **simultaneous installation of both technologies.** This policy aims to achieve better grid stability and increase the efficiency of renewable energy production.
- **Repowering Policy:** The Repowering Policy for Wind Power Projects was launched to replace **older wind turbines with newer,** more efficient models. This policy targets wind turbines retain original of a **capacity of 1 MW** and below, encouraging the use of advanced technology to enhance wind power generation from existing sites.

- **Renewable Purchase Obligations (RPO):** Under the RPO mechanism, obligated entities (such as electricity distribution companies) are **required to purchase a certain percentage of their total power from renewable energy sources.** This has driven the demand for **wind energy,** encouraging further investments in wind power projects.

With its strong growth, technical breakthroughs, and supporting government regulations, India's wind energy sector is set to expand significantly. Despite obstacles like site limits and environmental concerns, the sector's contribution to India's renewable energy aspirations and role in a sustainable future are unsurpassed.

Geothermal Energy

- **Geothermal energy,** produced from the Earth's interior heat, offers a sustainable and environmentally benign method for generating electricity and warmth. Utilising the thermal energy that the **Earth's core** naturally produces, this renewable energy source offers a steady and dependable power supply.
- Geothermal energy, which is especially common in areas with **volcanic or tectonic** activity, uses heat from beneath the Earth's surface to power homes, companies, and industries while minimising environmental damage.

World Geothermal Energy Scenario

- The **"Global Geothermal Market and Technology Assessment" report by the International Renewable Energy Agency (IRENA) in collaboration with the International Geothermal Association (IGA)** provides an in-depth analysis of the geothermal energy sector's current status, technological advancements, and future prospects.
- As of 2021, the global installed capacity for geothermal electricity generation reached **approximately 15.96 gigawatts electric (GWe),** accounting for a **modest 0.5%** of the renewable-based installed capacity for electricity generation and heating and cooling worldwide.
- Despite this, geothermal energy holds a unique position in the renewable energy mix due to its ability to provide both electricity and heat, as well as its potential for value-added mineral extraction.
- **Top Global Geothermal Energy Producers and Potential**
  - The report highlights the modest annual growth rate of around **3.5% in geothermal energy** for electricity generation.

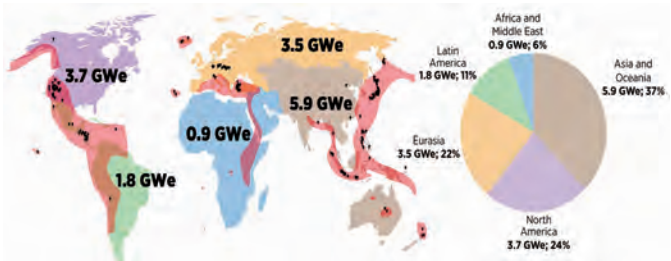


Fig. 4.23: Installed Geothermal Electricity Capacity by Region (2021)

  - However, geothermal energy's advantages, such as **reliable generation, high plant efficiency, low greenhouse gas emissions, and a small ecological footprint,** underscore its importance as a sustainable source when properly managed.
- **Challenges and Opportunities**
  - Geothermal development faces challenges including **long project-development timelines, high upfront capital expenditures,** and **high risk during early exploration** phases.
  - Other **barriers** include financing, policy and regulatory frameworks, institutional and technical expertise, and technological advancement.
  - Despite these challenges, opportunities for market growth exist, such as **leveraging oil and gas** expertise and technology, recovering minerals from geothermal brines, and promoting the use of geothermal resources for heating and cooling.

Geothermal energy's role in the global energy transition is being increasingly recognised, with its capacity to contribute to electricity grids' stabilisation and offer sustainable heating and cooling solutions. The report calls for enhanced efforts to overcome the existing barriers to geothermal energy development, highlighting the need for supportive policies, technological innovation, and international cooperation to unlock geothermal energy's full potential.

Geothermal Energy in India

- Geothermal energy is a growing frontier in India's **renewable energy** environment, taking advantage of the country's geological diversity to harness the Earth's natural heat.
- Despite being in its infancy compared to solar and wind energy, geothermal potential in India is enormous, particularly in locations known for **volcanic and tectonic activity.**

Types of Geothermal Energy Systems in India

India's exploration into geothermal energy encompasses a variety of applications and technologies:

- **Direct Use Applications:** These involve the direct utilisation of geothermal heat for various purposes, such as **space heating, aquaculture, and agricultural drying,** bypassing the need for complex power generation systems.
- **Geothermal Power Plants:** Although in the early stages of development, India is investigating the potential of geothermal power plants, including **dry steam, flash steam, and binary cycle** technologies, to convert geothermal energy into electricity.
- **Geothermal Heat Pumps:** Employed for both **heating and cooling** purposes, these pumps leverage stable underground temperatures to regulate building climates efficiently.

Working Principles of Geothermal Energy

The core of the earth, with temperatures comparable to the sun's surface, **radiates heat** to its surrounding rock and water layers. In certain regions, this geothermal heat approaches the Earth's surface, making it accessible for energy extraction:

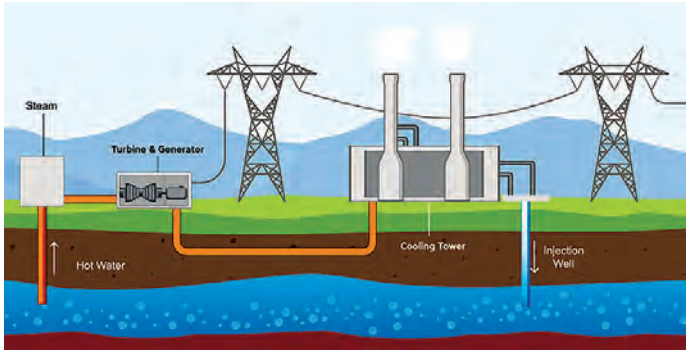


Fig. 4.24: Working Principles of Geothermal Energy

- **Direct Use and District Heating Systems:** Hot water extracted from beneath the ground is directly utilised for heating, after which it is **re-injected** into the earth to maintain the geothermal reservoir's sustainability.
- **Electricity Generation:** Geothermal power plants use the Earth's **steam or hot water to propel turbines,** which in turn generate electricity, showcasing a renewable method of power production akin to traditional power generation but with significantly lower environmental impacts.

Current Capacity and Potential in India

- **Installed Capacity:** As of 2023, **India has yet to commence** commercial geothermal power production. However, the exploration of potential sites, such as the **Puga Valley in Ladakh** and areas in **Arunachal Pradesh,** is underway.
- **Potential Capacity:** Preliminary estimates indicate that India could generate up to **10 GW** of power from geothermal sources, highlighting the untapped potential of this energy form.

Geothermal Energy Presence in India

- **Geothermal Sites:** India's geothermal prospects are primarily located in the **Himalayan region, Gujarat, and Chhattisgarh,** with ongoing site exploration to assess viability.
- **Hot Springs:** The country is home to approximately **340** identified geothermal hot springs, predominantly found in volcanic regions, serving as natural indicators of geothermal activity.

Development Factors

- **Government initiatives:** With the help of devoted research and development efforts, Indian policies are increasingly aiming to **incorporate geothermal energy** into the country's renewable energy mix.
- **Technological Research:** Ongoing studies focus on **identifying and adapting** technologies that can efficiently exploit India's unique geothermal resources.

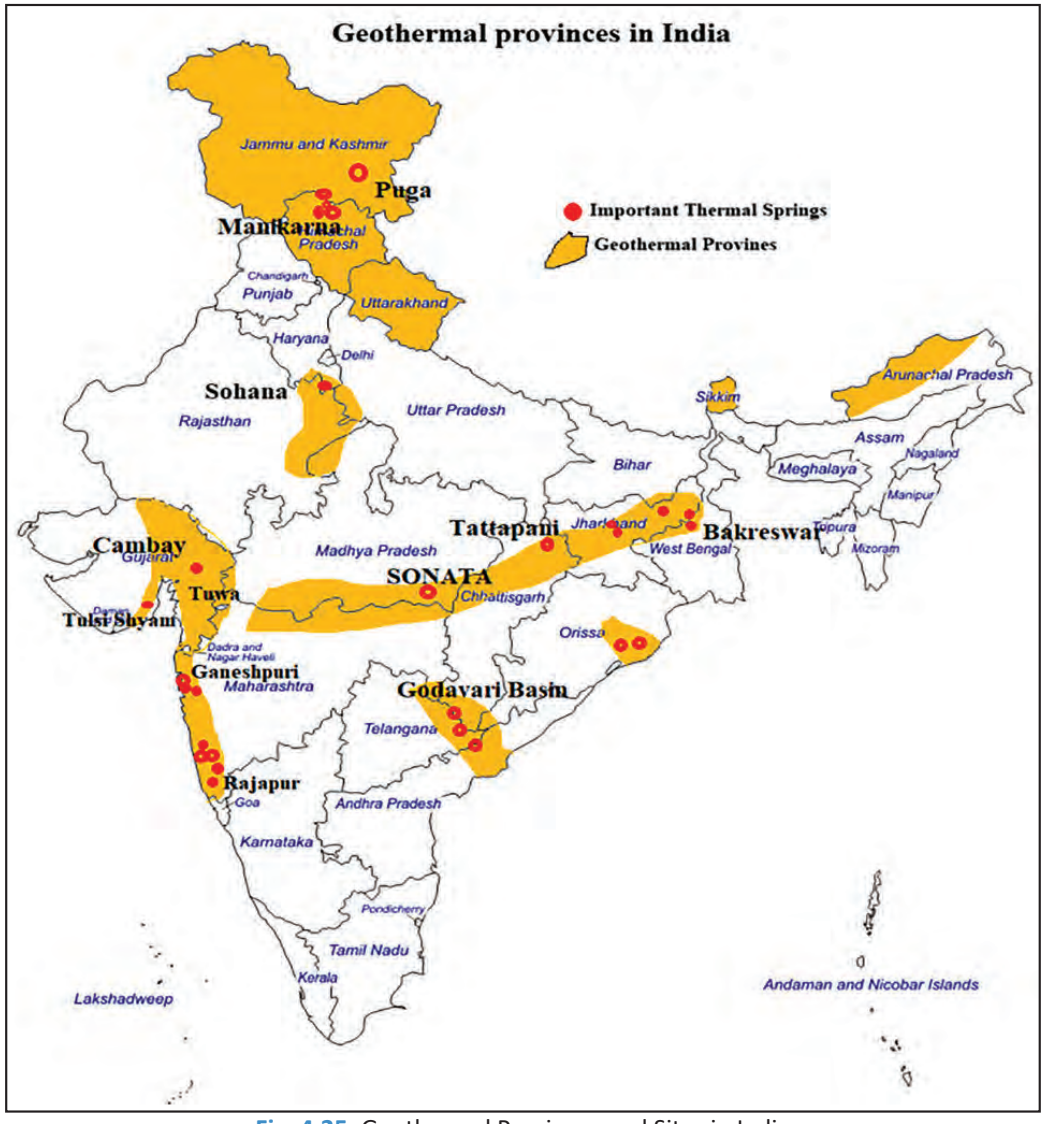


Fig. 4.25: Geothermal Provinces and Sites in India

- **Environmental Goals:** Geothermal energy aligns with India's **commitment to sustainable development** and **carbon emission reduction,** offering a clean power solution.
- **International Collaboration:** Partnerships with other nations are crucial for sharing knowledge, technology, and best practices in geothermal energy development.

Challenges in Geothermal Energy Development

Despite its potential, geothermal energy in India faces several hurdles:

- **Limited Exploration and Technology:** The nascent stage of geothermal exploration and the adaptation of suitable technologies pose significant challenges.
- **High Initial Costs:** The capital-intensive nature of geothermal **drilling and exploration** projects presents financial barriers to widespread adoption.
- **Environmental Concerns:** Potential environmental impacts, such as **land subsidence** and **greenhouse gas emissions,** necessitate careful planning and mitigation strategies.
- **Lack of Expertise:** A shortage of skilled professionals and technical knowledge in the geothermal sector hinders progress.

Steps taken by Government to Promote Geothermal Energy in India

India is making strides in harnessing geothermal energy, recognising its potential as a **sustainable and environmentally friendly power source.** The government, through the **Ministry of New and Renewable Energy (MNRE),** has initiated several steps to promote geothermal energy development:

Draft National Policy on Geo-Thermal Energy

- The Draft National Policy on Geo-Thermal Energy sets ambitious goals to significantly enhance India's geothermal energy production.
- The policy envisions establishing a **sustainable, secure, and environmentally responsible geothermal energy sector,** aiming to deploy **1000 MW of geothermal capacity by 2022 and scale up to 10,000 MW by 2030.**
- It focuses on exploring **multi-functional projects** to utilise geothermal resources nationwide and promoting research**, development, and demonstration (RD&D) projects** in geothermal power production and geo-exchange pumps.
- The policy aims to initiate **at least one project in all feasible states,** in line with the Ministry's R&D Policy guidelines.
- The policy encourages **international partnerships** and aims to attract foreign investments by permitting **100% foreign Direct Investment (FDI)** in the renewable energy sector.
- It also seeks to provide customised capacity-building programmes, technical support, and technological assistance to mitigate exploration risks.

India's effort to harness geothermal energy is characterised by both tantalising possibilities and substantial hurdles. Addressing these challenges through innovative legislation, technological breakthroughs, and international collaboration will be critical to realising geothermal energy's full potential as a component of India's renewable energy future.

Ocean Energy

- Ocean energy, a renewable resource produced from the **ocean's natural forces such as thermal gradients, tides, and waves,** has a massive and mostly unexplored potential for sustainable energy generation.
- This type of energy is especially promising for coastal areas, as it provides a consistent and stable power source with minimal environmental impact.

Global Ocean Energy Overview

- Ocean energy is still in its **early phases of development** when compared to other renewable sources such as solar and wind.
- However, its potential is tremendous, especially in countries with long coastlines and powerful ocean currents.
- **Potential Countries for Ocean Energy**
  - **United Kingdom:** The UK is a leader in tidal energy, with projects like the **Swansea Bay Tidal Lagoon** showcasing the country's commitment to tapping into ocean energy.
  - **Australia:** With its vast coastline, Australia has significant potential for wave energy and has invested in several pilot projects.
  - **France:** France has been exploring tidal energy in regions like **Brittany and Normandy,** aiming to leverage its coastal resources.

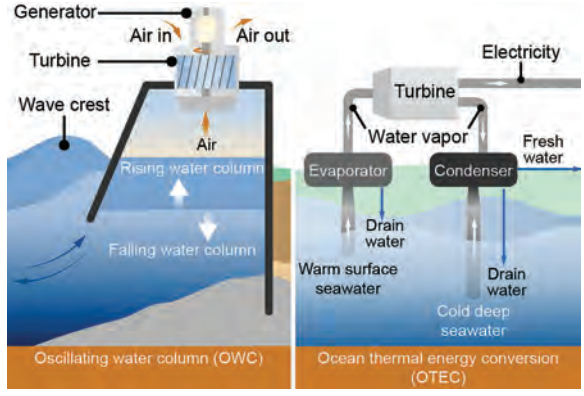


Fig. 4.26: Ocean Energy Generation

Fig. 4.27: Global Distribution of Ocean Energy Activity (active and projected power plants)

- **United States:** The US is exploring various forms of ocean energy, including wave energy off the coasts of **Oregon and California and OTEC in Hawaii.**
- **Canada: Canada's Bay of Fundy,** known for having the **highest tides in the world,** presents substantial opportunities for tidal energy development.

Ocean Energy in India

- Ocean energy in India is a **renewable energy frontier** with enormous potential that has yet to be completely realised.
- Harnessing the power of the sea, such as **tidal movements, wave energy, and ocean temperature gradients,** is a possible path for sustainable and clean power generation throughout India's vast coastline.
- While technologies such as tidal and wave energy are still in the development stages, India's strategic plans and research seek to capitalise on this underutilised resource.

Types of Ocean Energy Systems in India

India's exploration into ocean energy includes several innovative systems:

- **Tidal Energy:** Utilising the kinetic energy from tidal movements, India identifies potential in the **Gulf of Kutch and the Gulf of Cambay.** Tidal energy systems, such as tidal stream generators and barrage systems, capture the energy of tidal currents and the potential energy from tidal height differences, respectively.
- **Wave Energy:** This form of energy captures the **power from ocean waves.** While still in the experimental phase in India, wave energy converters aim to transform the kinetic and potential energy of waves into usable mechanical or electrical energy.
- **Ocean Thermal Energy Conversion (OTEC):** OTEC leverages the temperature differential between the **ocean's warmer surface water** and its **colder deep water** to generate electricity. This technology is particularly suited to tropical countries like India, offering a consistent energy output.
- **Salinity Gradient Energy:** Although not yet commercially explored in India, this energy is produced from the **difference in salt concentration between seawater and river water.** Technologies like **Pressure Retarded Osmosis and Reverse Electrodialysis** generate power by exploiting osmotic pressure differences or through electrochemical processes.

Current Capacity and Potential

- As of 2023, India's commercial capacity for ocean energy remains **minimal.**
- However, the country's **theoretical potential** is estimated at about **54 gigawatts,** encompassing tidal and wave energy.
- The **Gulf of Kutch and the Gulf of Cambay** are notable for their tidal energy potential, while India's extensive coastline offers numerous opportunities for wave energy and OTEC development.

IGNITE YOUR MIND

Hidden Energy Treasures: Geothermal power, tidal energy, and wave energy are all promising renewable sources. What are the challenges of tapping into these hidden energy reserves?

Development Factors for Ocean Energy in India

Several important factors are driving the development of ocean energy in India:

- **Government Initiatives:** The **Ministry of New and Renewable Energy's** recognition of ocean energy as a renewable source marks a significant step towards its development.
- **Research and Development:** Ongoing efforts aim to assess the **feasibility and efficiency** of ocean energy technologies, with a focus on adapting these systems to Indian maritime conditions.
- **Environmental Considerations:** Ocean energy aligns with India's goals for **sustainable and clean energy,** offering a low-impact alternative to fossil fuels.
- **Economic Potential:** Despite high initial costs, technological advancements could render ocean energy a **cost-effective** solution in the **future.**

Challenges in Ocean Energy Development

The path to harnessing ocean energy in India is fraught with challenges:

- **Technological and Adaptation Hurdles:** The nascent stage of ocean energy technologies necessitates significant research and adaptation to optimise performance and efficiency in India's unique maritime environment.
- **Financial Barriers:** High capital and operational costs, exacerbated by the marine environment's harshness, present substantial financial challenges to ocean energy projects.
- **Environmental and Marine Concerns:** Understanding the ecological impacts of ocean energy projects is crucial, requiring comprehensive environmental assessments to mitigate potential adverse effects on marine ecosystems.
- **Grid Integration Complexities:** Connecting remote ocean energy installations to the national grid involves technical and financial challenges, including undersea cabling.
- **Site Selection and Planning:** Identifying suitable sites for ocean energy projects must balance energy potential with ecological conservation and maritime activities, often leading to conflicts and delays.

- **Policy and Regulatory Framework:** The lack of a dedicated policy and regulatory framework for ocean energy in India impedes project development and access to financial incentives.

Steps taken by Government to Promote Ocean Energy in India

Recognising the tremendous potential of ocean energy as a renewable resource, the Indian government has launched a number of initiatives and projects to promote its development. Ocean energy, which includes tidal, wave, and thermal energy conversion, provides a sustainable alternative to traditional power sources.

- **Inclusion of Ocean Energy as Renewable Energy:** In 2019, **the Ministry of New and Renewable Energy (MNRE) officially classified ocean energy as a renewable energy source.** This classification allows ocean energy projects to avail of various benefits under the national renewable energy policies, including financial incentives, easier credit terms, and a more favourable regulatory environment.

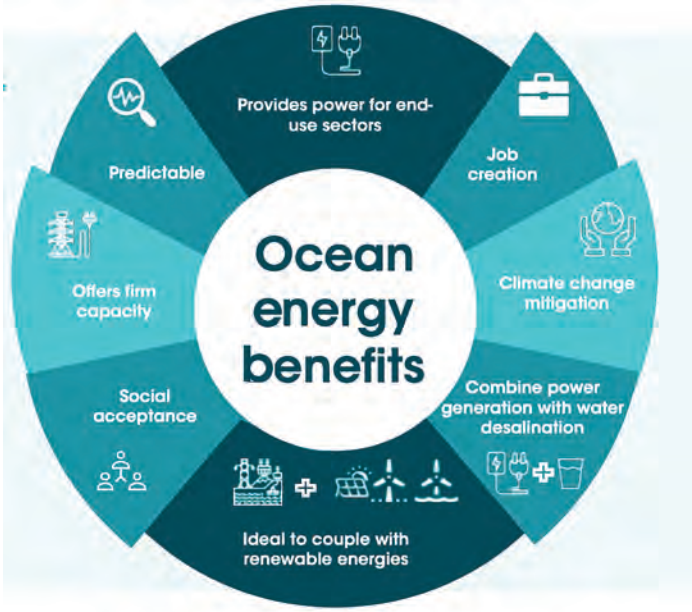


Fig. 4.28: Ocean Energy Benefits

- **Research & Development Initiatives:** The MNRE supports R&D activities in the field of ocean energy. The government funds projects at various research institutions and universities across the country to explore and develop technologies for harnessing energy from the ocean. This includes studies on wave energy, tidal energy, and Ocean Thermal Energy Conversion (OTEC).
- **Government Research Institutions: National Institute of Ocean Technology (NIOT)** play a crucial role in ocean energy development. NIOT, under the **Ministry of Earth Sciences,** conducts research and technological development projects in ocean energy, including the development of prototype devices for harnessing wave and thermal energy.
- **International Collaborations:** India engages in international collaborations to advance its ocean energy sector. Partnerships with countries that have advanced ocean energy technologies allow for knowledge exchange, capacity building, and joint research projects.
- **Demonstration Projects:** To showcase the potential of ocean energy, the government supports demonstration projects. These projects aim to prove the technical **feasibility and economic viability** of ocean energy technologies in the Indian context, encouraging private investment in the sector.

Ocean energy in India, with its great potential and connection with environmental ideals, confronts a difficult road to commercial viability. Overcoming these hurdles through targeted research, supportive legislation, and technical innovation would be critical for India to harness the tremendous potential of the ocean and contribute to a more sustainable and diverse energy future.

Biomass Energy

- Biomass energy, obtained from organic materials such as **wood, agricultural products, or trash**.
- It performs a variety of functions, including **heating, electricity generation, and biofuels,** providing a sustainable energy source when handled correctly.
- Despite its benefits, biomass energy produces some pollutants when burned, necessitating cautious and prudent management to maximise its environmental benefits.

Biomass Energy in India

- Biomass energy in India uses the country's **plentiful organic materials,** such as **agricultural waste, wood, and crop residues,** to generate a sustainable and **renewable source of electricity.**
- This type of energy is critical to India's renewable energy policy, providing solutions for **power generation, heating, and biofuel manufacturing.**

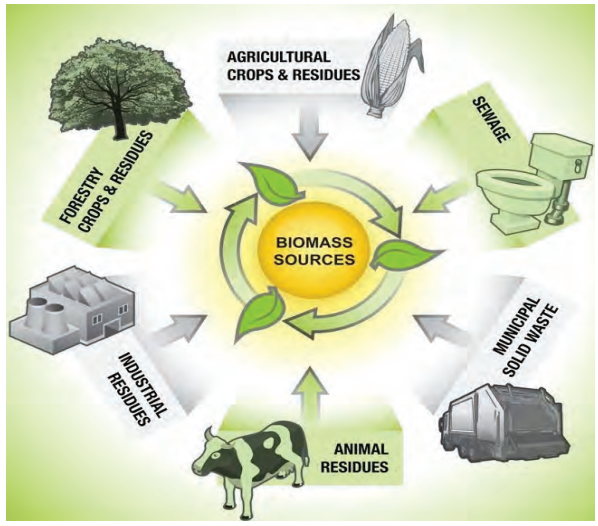


Fig. 4.29: Biomass Energy

- India is leveraging biomass energy systems, such as **power plants, cogeneration, waste-to-energy** facilities, and gasification processes, to fulfil its expanding energy demands.

Current Capacity and Growth

- **Installed Capacity:** India's biomass production capacity reached **10 GW in fiscal year 2022,** with a compound annual growth rate of **4%**, showcasing steady growth in the sector.
- **Energy Generation:** Biomass energy is a significant contributor to India's renewable energy mix, with an increasing focus on **waste-to-energy projects** to leverage urban waste.

Areas of Presence and Factors Driving Development

- **Geographical Spread:** Biomass energy facilities are prevalent across India, especially in agricultural states like **Punjab, Haryana, and Uttar Pradesh,** where feedstock availability is high.
- **Government Policies:** Initiatives like the **National Bioenergy Programme and the Biomass Programme under the Ministry of New and Renewable Energy (MNRE)** provide crucial support, promoting the use of briquettes, pellets, and biomass-based cogeneration.
- **Abundant Biomass Resources:** India's extensive agricultural activities supply ample biomass feedstock, supporting the sector's growth.
- **Waste Management and Rural Development: Waste-to-energy** projects not only help manage urban waste but also contribute to rural development by creating jobs and providing **additional income sources for farmers.**

Challenges in Biomass Energy Development

Despite its potential, the biomass energy sector in India faces several challenges:

- **Supply Chain and Logistics:** Establishing a **reliable biomass feedstock** supply chain requires sophisticated logistics, particularly in remote areas.
- **Technological Limitations:** The need for **more advanced and efficient biomass** conversion technologies remains, as current efficiencies are **relatively low.**
- **Competition with Agriculture:** Utilising **agricultural residues** for energy competes with their traditional uses, potentially impacting soil health and food security.
- **Financial Viability:** The economic sustainability of biomass projects is often challenged by **fluctuating feedstock prices** and the necessity for significant upfront investment.

IGNITE YOUR MIND

Biomass: Friend or Foe? Using crops and waste for energy can be sustainable, but it can also lead to deforestation and food insecurity. How can we balance these competing needs?

Steps taken by Government to Promote Biomass Energy in India

The **Ministry of New and Renewable Energy (MNRE)** in India has initiated several schemes to promote biomass energy, leveraging the country's abundant biomass resources for power generation, heating, and other applications.

- **Biomass Power and Bagasse Cogeneration Programme:** This programme aims to promote the use of biomass for power generation and the cogeneration of power from **bagasse in sugar mills.** It provides **Central Financial Assistance (CFA)** to set up new biomass power projects and bagasse cogeneration projects in industries.
- **Waste to Energy Programme:** The Waste to Energy Programme focuses on generating energy from **urban and industrial waste.** It supports projects that convert waste materials, including municipal solid wastes, sewage, and industrial wastes, into energy in the form of electricity, heat, or biogas.
- **National Biogas and Manure Management Programme (NBMMP):** The NBMMP **promotes the use of biogas for cooking and lighting in rural areas.** It provides financial support for setting up family-type biogas plants, primarily targeting rural and semi-urban households.
- **Programme on Energy from Urban, Industrial, and Agricultural Wastes/Residues:** This initiative encourages the recovery of energy from various wastes and residues, including agricultural residues, urban waste, and industrial by-products.
- **Biomass Gasifier Programme:** The Biomass Gasifier Programme supports the **installation of biomass gasifiers for both thermal and electrical applications in rural and urban areas.** It aims to provide a reliable and clean energy source for industries, institutions, and communities by converting biomass materials into a combustible gas.
- Other Initiatives: **The Ministry of Petroleum and Natural Gas,** under the **Sustainable Alternative Towards Affordable Transportation (SATAT) initiative**, encourages entrepreneurs to set up **BioCNG plants,** produce & supply BioCNG to Oil Marketing Companies (OMCs) for sale as automotive fuels. The Department of **Drinking Water and Sanitation (DDWS)** launched the **Galvanizing Organic Bio-Agro Resources Dhan (GOBAR-DHAN)** scheme in 2018.

Biomass energy is an important component of India's renewable energy mix, paving the way for sustainable and clean energy. Addressing logistical, technological, and financial problems would be critical to realising the full potential of biomass energy and contributing to India's energy security and environmental goals.

RENEWABLE ENERGY: WAY TOWARDS SUSTAINABILITY

Renewable energy is at the forefront of the worldwide shift to sustainability, providing a means to reduce environmental impact, improve energy security, and promote economic development. The following are the benefits of renewable energy:

- **Reduction in Greenhouse Gas Emissions:** Renewable energy sources like wind, solar, and hydroelectric power produce little to **minimal greenhouse gas emissions during operation,** significantly reducing the carbon footprint associated with energy production.
- **Diversification of Energy Sources:** By investing in renewable energy, countries can diversify their energy mix and **reduce dependence on imported fossil fuels**, enhancing national energy security.
- **Job Creation:** The renewable energy sector is **labour-intensive** and can create a significant number of jobs in manufacturing, installation, and maintenance of renewable energy technologies.
- **Advancements in Energy Storage:** Innovations in energy storage technologies, such as **batteries and pumped hydro storage,** are crucial for integrating intermittent renewable energy sources into the grid.
- **Access to Energy in Remote Areas:** Renewable energy technologies, especially solar and wind, can provide access to electricity in **remote and rural areas,** improving living standards and economic opportunities.
- **Supportive Policies and Incentives:** Government policies, including **subsidies, tax incentives, and feed-in tariffs,** play a critical role in promoting the adoption and development of renewable energy technologies.
- **Global Commitments to Climate Action:** International agreements, such as the **Paris Agreement,** underscore the collective commitment of nations to increase the use of renewable energy and combat climate change.

Renewable energy plays a multidimensional role in achieving sustainability, including environmental, economic, and social factors. By leveraging the power of renewable resources, society can get closer to achieving sustainable development goals and leaving a better planet for future generations.

IGNITE YOUR MIND

Climate Countdown: Burning fossil fuels is like playing climate roulette. Can we transition to clean energy fast enough to avoid rolling the dice on environmental catastrophe? Can we achieve energy security while combating climate change? Discuss potential solutions and trade-offs.

GEOPOLITICS OF NATURAL RESOURCES

- The geopolitics of natural resources examines the **strategic importance of worldwide distribution, production, and use of critical resources** like oil, natural gas, minerals, water, and arable land.
- These resources, which are critical to **economic and military strength,** are at the centre of geopolitical dynamics, impacting global relations, economic development, and security policy.
- The interaction of control, scarcity, security, and environmental concerns defines the complex landscape of resource geopolitics.

Dimensions of Natural Resources Geopolitics

- **Control and Access**
  - Nations rich in natural resources, such as **Saudi Arabia with its oil reserves,** exert considerable geopolitical influence.
  - **Saudi Arabia's Vision 2030,** for example, aims to **diversify its economy beyond oil,** reflecting the strategic use of resource wealth for broader economic goals.
- **Resource Scarcity and Competition**
  - The competition for scarce resources can lead to tensions, as seen in the **South China Sea disputes over oil and gas reserves,** underscoring the link between resource availability and regional stability.
- **Energy Security**
  - The **Russia-Ukraine conflict** highlights the importance of **energy security**, with **European nations** reevaluating their energy strategies to reduce reliance on Russian gas, illustrating the strategic alliances and diversification efforts countries undertake to secure their energy supplies.
- **Economic Development**
  - Countries like **Australia** that are rich in minerals and natural resources, leverage these assets for economic growth.
  - However, the **"resource curse"** can pose challenges, making economies vulnerable to commodity price fluctuations.

- **Environmental Considerations**
  - The global shift towards sustainability has intensified focus on renewable energy sources, as seen in the **international push for electric vehicles (EVs)** and the corresponding demand for lithium, spotlighting the environmental impact of resource extraction and consumption.
- **International Relations and Trade**
  - Trade policies and international relations significantly impact resource geopolitics.
  - The **U.S.-China trade tensions over rare earth elements** exemplify how resources can become focal points in broader geopolitical conflicts.
- **Technological Advancements**
  - Technological progress, such as advancements in renewable energy technologies, reshapes the geopolitical landscape.
  - The development of **hydraulic fracturing (fracking) technology in the United States,** for example, has transformed the country into one of the world's largest oil and gas producers, altering global energy markets and reducing dependency on traditional energy suppliers.

The intricate interplay between natural resources and geopolitical agendas emphasises the significance of long-term management, diversification, and international cooperation in navigating the difficulties and opportunities posed by global natural resource distribution.

IGNITE YOUR MIND

Resource Rivalry: Access to energy resources can spark conflicts between nations. How can we ensure equitable distribution and avoid resource wars?

GLOBALISATION AND UNSUSTAINABLE EXPLOITATION OF NATURAL RESOURCES

- Globalisation has made the world's economy, cultures, and populations **more intertwined than ever before.**
- While globalisation has fueled economic growth and technical progress, it has also raised demand for natural resources, resulting in unsustainable exploitation.
- This exploitation presents substantial environmental, economic, and social challenges.

Examples of Unsustainable Exploitation of Natural Resources

- **Deforestation in the Amazon Rainforest**
  - The Amazon, often referred to as the **"lungs of the Earth,"** has seen accelerated deforestation due to **globalization-driven demands for agricultural land,** particularly for **soy production and cattle ranching.**
  - This deforestation contributes to biodiversity loss, greenhouse gas emissions, and the displacement of indigenous communities.
- **Overfishing in the World's Oceans**
  - Global demand for seafood has led to **overfishing,** threatening marine ecosystems.
  - Species such as the **Atlantic bluefin tuna** have been fished to the brink of extinction, disrupting food chains and marine biodiversity.
- **Water Scarcity and Pollution**
  - **Fast fashion** fuels the global textile industry, which uses enormous amounts of water and releases pollutants into waterways.
  - Countries like **Bangladesh,** a major garment producer, face severe water pollution and scarcity issues as a result.
- **Rare Earth Elements (REE) Mining**
  - The demand for REEs, essential for manufacturing high-tech devices, has led to **environmentally damaging mining practices.**
  - In **China,** REE mining has resulted in soil and water contamination, posing health risks to local populations.

Addressing Unsustainable Exploitation

- To mitigate the unsustainable exploitation of natural resources, a multifaceted approach is needed, including:
  - **Sustainable Resource Management:** Implementing policies and practices that ensure the sustainable use of resources, such as sustainable forestry, fisheries management, and water use efficiency.
  - **Technological Innovation:** Developing and adopting cleaner, more efficient technologies to reduce environmental impacts and resource consumption.
  - **Consumer Awareness and Behaviour Change:** Encouraging consumers to make more sustainable choices, such as supporting ethically sourced products and reducing waste.
  - **International Cooperation:** Strengthening global governance and cooperation to address transboundary environmental issues and promote sustainable development practices.

Globalisation creates both **obstacles and opportunities** for sustainable development. Recognising the interconnection of global systems allows civilizations to collaborate to guarantee that the exploitation of natural resources is handled in a way that fulfills current requirements **without jeopardising future generations'** ability to meet theirs.

DEPLETION OF NATURAL RESOURCES VERSUS ECONOMIC GROWTH

- The relationship between natural resource depletion and economic growth is **complicated,** with characteristics such as **environmental sustainability, economic development, and social equality.**
- While economic growth has traditionally been based on the consumption of natural resources, irresponsible exploitation can cause environmental degradation, compromising long-term economic stability and quality of life.
- Below, we examine various facets of this relationship with examples.

Environmental Dimension

- **The Great Barrier Reef,** a critical natural resource for Australia, faces threats from climate change, pollution, and overfishing.
- Its degradation not only impacts biodiversity but also Australia's economy, particularly **tourism,** which relies heavily on the reef's health.
- The Australian government and organisations are working on conservation efforts to protect this natural asset.

Economic Dimension

- Countries rich in **natural resources, like Venezuela** with its oil reserves, often experience what's known as the **"Dutch Disease,"** where reliance on resource exports leads to a decline in other sectors like manufacturing and agriculture.
- This can make economies vulnerable to resource **price volatility.**

Social Dimension

- The extraction of minerals in the **Democratic Republic of the Congo (DRC),** such as **coltan** (used in electronics), has fueled conflict and human rights abuses.
- The international community has sought to address these issues through initiatives like the **Dodd-Frank Act,** which requires companies to disclose their use of **conflict minerals.**

Technological Dimension

- The global shift towards renewable energy sources, such as solar and wind, illustrates how technological innovation can reduce dependency on finite natural resources and foster sustainable economic growth.
- Countries like **Germany,** through its Energiewende (energy transition) policy, are leading this transition.

Policy Dimension

- China has implemented **stringent environmental policies** to combat pollution and resource depletion, including investing in green technologies and imposing restrictions on coal consumption.
- These policies aim to balance economic growth with environmental sustainability.

These instances highlight the complex interplay between natural resource depletion and economic growth. Sustainable management, technical innovation, and international cooperation are critical to ensuring that economic development does not result in environmental damage or social inequity.

ELECTRICITY GENERATION IN INDIA

Electricity generation in India is a **complex and evolving landscape**, characterised by a diverse mix of energy sources, regional disparities in generation and consumption, and various challenges that necessitate comprehensive policy responses and strategic planning for the future.

Regional Pattern of Electricity Generation and Consumption

- Electricity generation and consumption in India exhibit marked **regional variations,** influenced by factors such as **resource availability, industrial activity, and population density.**
- **Northern and Western** regions, with their extensive **industrial bases,** are among the highest electricity consumers.
- The **Southern region,** despite having a robust industrial sector, has significantly invested in **renewable energy,** particularly wind and solar, to meet its demands.
- **Eastern and Northeastern regions,** rich in **coal and hydro resources,** respectively, contribute substantially to the national grid but face challenges in infrastructure and transmission losses.
- In the year **2018-19**, the top 5 states/UTs in India with the highest per capita consumption were **Dadra & Nagar Haveli: 15179 kWh, Daman & Diu: 7758 kWh, Gujarat: 2378 kWh, Goa : 2274 kWh and Haryana: 2082 kWh**

Challenges of Electricity Sector

- **Environmental Impact:** The reliance on coal and other fossil fuels for electricity generation has raised concerns over **carbon emissions** and **air pollution.**
- **Transmission Losses:** India's power transmission networks experience significant losses, attributed to **outdated infrastructure and theft.**
- **Access and Equity:** Despite improvements, rural areas and certain urban populations still face issues with **electricity access and reliability.**

- **Financial Health of Utilities:** Many of India's **state-owned electricity distribution companies (DISCOMS)** are financially stressed, affecting their operational efficiency and ability to invest in infrastructure.

Steps Taken to Address the Issues

- **Renewable Energy Push:** The Indian government has set ambitious targets for renewable energy capacity, aiming to reach **450 GW by 2030.**
- **UDAY Scheme:** The **Ujwal DISCOM Assurance Yojana (UDAY)** was launched to improve the financial and operational efficiencies of state-owned DISCOMS.
- **Grid Modernization:** Investments in smart grid technologies and infrastructure upgrades are underway to reduce transmission losses and improve reliability.
- **Electrification Initiatives:** Programmes like the **Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya)** aim to ensure universal household electrification.

Way Forward

- **Diversification and Decarbonization:** Continuing to diversify the energy mix with a greater emphasis on renewables and cleaner technologies is crucial for sustainable growth.
- **Energy Efficiency:** Enhancing energy efficiency across **industries, buildings, and appliances** can reduce overall demand and strain on the grid.
- **Policy and Regulatory Reforms:** Strengthening policy frameworks and regulatory mechanisms to **attract investment, ensure fair pricing, and promote innovation is essential.**
- **Regional Integration:** Developing regional energy markets and interconnections can help balance supply and demand more effectively across the country.

India's journey towards a more sustainable, reliable, and equitable electricity system is ongoing, requiring concerted efforts from the government, private sector, and civil society to address existing challenges and harness emerging opportunities for growth and development.

ENERGY CRISIS

- An energy crisis occurs when the supply of **energy becomes insufficient** to satisfy demand, causing substantial economic and societal effects.
- Physical shortages, **market failures, regulatory inefficiencies, and geopolitical conflicts** are all potential causes of energy crises.
- An energy crisis has far-reaching consequences, affecting both individual homes and global economies.

Causes of Energy Crises

- **Resource Depletion:** Non-renewable resources like oil, natural gas, and coal are finite. Over-reliance on these resources can lead to depletion, causing supply shortages.
- **Geopolitical Conflicts:** Many energy resources are concentrated in geopolitically unstable regions. Conflicts in these areas can disrupt supply chains, leading to shortages and price spikes.
- **Natural Disasters:** Hurricanes, earthquakes, and other natural disasters can damage infrastructure, disrupting energy production and distribution.
- **Regulatory and Policy Challenges:** Inadequate policies or regulatory frameworks can lead to underinvestment in energy infrastructure and technologies, hindering supply capabilities.
- **Market Manipulation:** Organisations like OPEC can influence oil prices by controlling production levels, leading to artificial shortages or price increases.
- **Increased Demand:** Rapid industrialization, economic growth, and population increases can lead to surges in energy demand that outpace supply.

IGNITE YOUR MIND

Power Outage Panic: Imagine your city plunged into darkness due to an energy crisis. Panic sets in, and resources dwindle. As a community leader, what bold choices would you make to share dwindling power and spark innovative solutions.

Impacts of Energy Crises

- **Economic Disruption:** Energy is a critical input for nearly all economic activities. Shortages can lead to increased costs for businesses and consumers, inflation, and economic downturns.
- **Social Unrest:** High energy prices or shortages can lead to public dissatisfaction, protests, and, in extreme cases, civil unrest.
- **Environmental Damage:** In the scramble to meet energy needs, countries may resort to **exploiting more environmentally damaging** resources or technologies.
- **Energy Poverty:** Rising energy costs can disproportionately affect **low-income households,** leading to energy poverty, where families are unable to afford basic heating or cooling.

Solutions and Mitigation Strategies

- **Diversification of Energy Sources:** Investing in a **mix of renewable and non-renewable energy** sources can reduce dependency on any single source and enhance energy security.
- **Energy Efficiency:** Improving **energy efficiency in industries**, buildings, and transportation can reduce overall demand and alleviate pressure on supply.
- **Technological Innovation:** Advancements in energy technologies, such as **battery storage, smart grids, and carbon capture,** can improve the resilience of energy systems.

- **Policy and Regulatory Reforms:** Effective policies and regulations can encourage investment in energy infrastructure, promote renewables, and ensure fair market practices.
- **International Cooperation:** Global challenges require global solutions. **International cooperation** can help stabilise energy markets, share technologies, and coordinate responses to crises.
- **Public Awareness and Behavioural Change:** Educating the public about energy conservation and promoting sustainable consumption behaviours can play a critical role in managing demand.

ENERGY SECURITY: ENERGY POLICY AND STRATEGY IN INDIA

- Energy security, a vital component of **national security and economic stability,** entails guaranteeing a consistent and sufficient supply of energy at reasonable prices.
- Given India's growing economy, population, and reliance on imported fossil fuels, energy security presents a **multidimensional problem.**
- The Indian government has established a variety of policies and methods to solve these issues and maintain energy security.

Diversification of Energy Sources

- India is actively working to **diversify its energy mix** by reducing dependence on **imported fossil fuels** and increasing the share of renewables in its energy portfolio.
- The **National Solar Mission** and the **National Wind Energy Mission** are examples of initiatives aimed at promoting solar and wind energy, respectively.

Enhancing Domestic Production

- The government is focusing on enhancing domestic production of oil and natural gas through policies like the **Hydrocarbon Exploration and Licensing Policy (HELP)** and the **Discovered Small Fields (DSF) policy** to improve energy self-sufficiency.

Energy Efficiency and Conservation

- India has launched several programmes aimed at energy conservation and efficiency, such as the **Perform, Achieve, and Trade (PAT) scheme** and the **Standards & Labelling programme,** managed by the **Bureau of Energy Efficiency (BEE).**

Strengthening Energy Infrastructure

- Investments in energy infrastructure, including the expansion of the **gas pipeline network** and the **modernization of the power grid,** are crucial for enhancing energy security.
- The **Ujwal DISCOM Assurance Yojana (UDAY)** aims to improve the financial and operational efficiencies of power distribution companies.

Strategic Petroleum Reserves

- India is developing **strategic petroleum reserves** to mitigate the impact of global oil price volatility and supply disruptions.
- These reserves act as a buffer during emergencies.

International Collaborations

- India is engaging in international collaborations and partnerships to secure access to energy resources.
- This includes **bilateral agreements with oil-producing nations** and participation in international energy forums.
- It includes initiatives like International Solar Alliance, US-India Strategic Energy Partnership (SEP), India-Russia Energy Bridge, etc.

Renewable Energy Investments

- The government encourages investment in renewable energy through incentives and policies to attract private and foreign investments, aiming to achieve its ambitious renewable energy targets.

India's strategy for energy security is comprehensive, addressing both the supply and demand sides of the energy equation. India plans to achieve a sustainable and secure energy future through a combination of regulatory initiatives, strategic investments, and international partnerships.

THE WAY FORWARD

The future of emerging **cutting-edge energy technologies** holds immense promise for addressing the challenges of **climate change**, resource scarcity, and energy security. Here are some key strategies and areas of focus that can drive the way forward:

- **Investment in Research and Development (R&D):** Continued investment in R&D is crucial for advancing new energy technologies. Governments, private sector entities, and research institutions should collaborate to fund research into areas such as advanced materials, **energy storage**, **renewable energy**, and **nuclear fusion**.
- **Renewable Energy Integration:** Focus on integrating **renewable energy sources** like solar, wind, and hydro into existing energy infrastructure. This includes improving grid flexibility, energy storage solutions, and developing smart grid technologies to manage intermittent renewable energy sources effectively.
- **Energy Storage:** Develop cost-effective and efficient energy storage solutions such as batteries, pumped hydro, **hydrogen storage**, and thermal storage. Advances in energy storage technology will enable better integration of renewable energy sources into the grid and support the electrification of transportation and heating.

- **Electrification of Transportation:** Accelerate the transition to **electric vehicles (EVs)** and support the development of charging infrastructure. This shift reduces greenhouse gas emissions from the transportation sector and creates opportunities for vehicle-to-grid (V2G) technologies that enable EVs to store and discharge electricity to the grid.
- **Advanced Nuclear Technologies:** Explore next-generation nuclear technologies such as small modular reactors (SMRs), advanced fission reactors, and **nuclear fusion**. These technologies offer the potential for carbon-free baseload power generation with enhanced safety features and reduced nuclear waste.
- **Decentralized Energy Systems:** Promote the development of decentralized energy systems, including **microgrids** and distributed energy resources (DERs) like rooftop solar panels and small-scale wind turbines. These systems enhance energy resilience, reduce transmission losses, and empower communities to generate their own clean energy.
- **Carbon Capture, Utilization, and Storage (CCUS):** Invest in CCUS technologies to capture and store carbon dioxide emissions from industrial processes and power plants. Additionally, explore opportunities for carbon utilization in products and materials to create economic incentives for carbon capture.
- **Hydrogen Economy:** Foster the development of a **hydrogen economy** by investing in hydrogen production technologies, such as electrolysis powered by renewable energy, and supporting the deployment of hydrogen fuel cells in various applications, including transportation, heating, and industrial processes.
- **Policy Support and Regulatory Frameworks:** Implement supportive policies and regulatory frameworks to incentivize innovation, investment, and deployment of emerging energy technologies. This includes **carbon pricing** mechanisms, **renewable energy targets**, research grants, and tax incentives for clean energy investments.
- **International Collaboration:** Foster international collaboration and knowledge sharing to accelerate the development and deployment of **cutting-edge energy technologies**. Collaborative efforts can leverage diverse expertise, resources, and infrastructure to address global energy challenges effectively.

By pursuing these strategies and priorities, we can pave the way for a sustainable energy future powered by innovative and environmentally friendly technologies.

CONCLUSION

The chapter's assessment of **conventional and non-conventional energy sources** emphasises the critical need for a shift to sustainable and renewable energy to solve the **multidimensional concerns** of **environmental degradation, economic volatility, and geopolitical tensions.** It emphasises the importance of implementing a complete approach that involves **diversifying energy sources, increasing efficiency, encouraging innovation, and bringing policy changes**. In summary, a deliberate shift towards renewable energy, combined with strategic policy and technological breakthroughs, is critical for ensuring a sustainable and resilient energy future as opposed to the current scenario of energy crisis.

The World Population: Distribution, Density, Growth & Composition

5

A population comprises individuals of the same group or species cohabiting and reproducing in a specific region. Members of a population typically share resources, face comparable environmental limitations, and rely on the presence of fellow members for long-term sustainability.

POPULATION GEOGRAPHY

Population geography, a **subset of human geography**, concentrates on the systematic exploration of individuals, their spatial arrangements, and population density.

- Population geographers investigate population fluctuations, migration patterns, settlement trends, and factors like occupation, **contributing to the geographic identity of a region**.
- Population geography shares a **close association with demography,** which involves the study of population statistics and trends.

Population Growth

Population growth is generally described as the fluctuation in the quantity of **individuals within a specific area** over a given period.

- **Calculating Population Growth Rate:** The population growth rate is determined by subtracting the number of individuals leaving an area from those entering it. This involves adding the birth and immigration rates and subtracting the death and emigration rates.

THE WORLD POPULATION

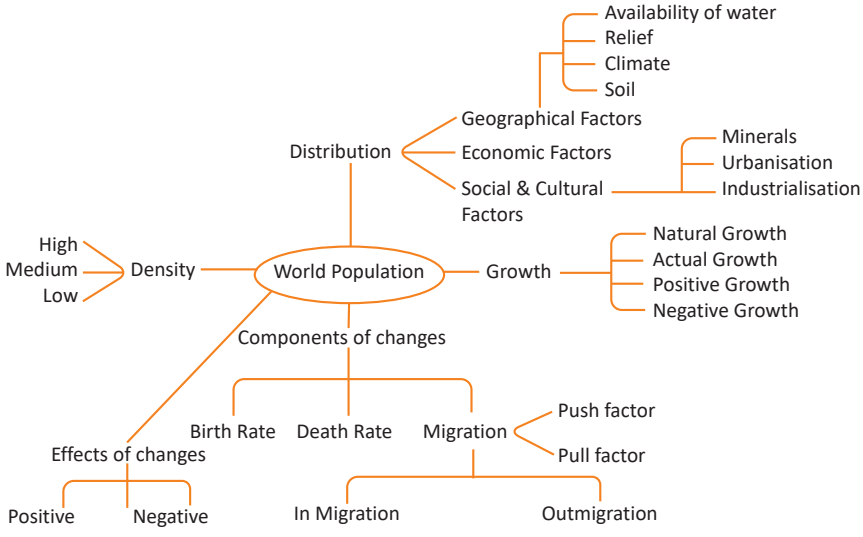


Fig 5.1: World Population and Demographic Factors

Growth rate = Birth rate – Death rate + Immigration rate – Emigration rate

Factors Influencing Population Trends

Population trends are influenced by a complex interplay of environmental, economic, and social factors. From climate conditions to economic development levels and cultural practices, various elements shape population dynamics. Understanding these influences is crucial for comprehending demographic patterns and trends.

Environmental Factors:

- **Climate:**
  - Equatorial and tropical climates, known as the **"land of sickness,"** are prone to diseases.
  - **Monsoon climate areas** are called the 'land of slackness' due to the humid conditions.
  - These regions with sick and slack societies may struggle with development, leading to an **inward-looking social system**.
  - Couples in these areas tend to live together for most of the time, **fostering a subsistence economy and traditional society**.
- **Disasters:**
  - Environmental disasters can hinder development, influencing social factors related to population growth.

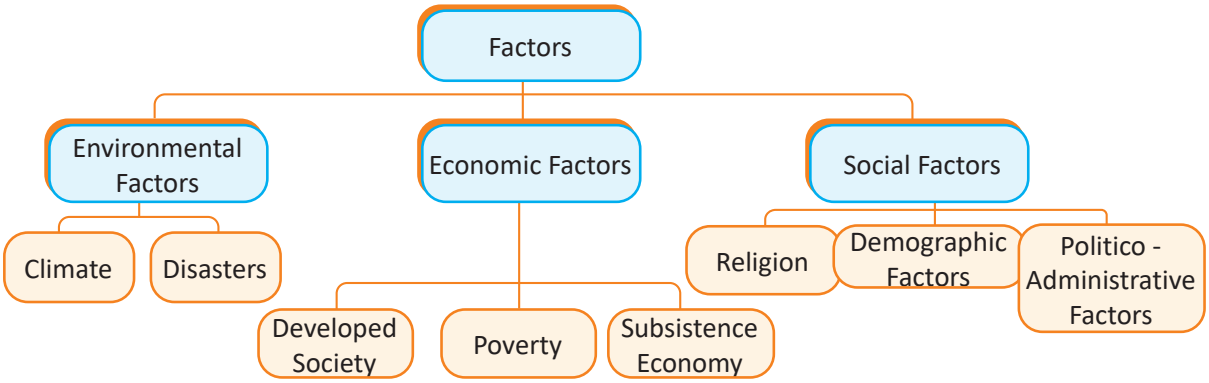


Fig. 5.2: Factors Influencing the Growth of the Population

Economic Factors

❑ **Developed Society:**

- Developed societies generally experience slower population growth, showing an inverse relationship between income and population.

❑ **Poverty:**

- Poverty is a significant factor contributing to population growth. According to **Adam Smith** (in his seminal work "An Inquiry into the Nature and Causes of the Wealth of Nations"), poverty creates an environment with a high fertility rate for the poor, and children are considered assets rather than liabilities.
- According to World Bank, about eight percent of the global population, live in extreme poverty in 2019, which means they subsist on **less than US$2.15 per day**. South Asia accounts for 24 percent of the extreme poor in 2019.

❑ **Subsistence Economy:**

- Developing countries, especially those with monsoonal climates or engaged in paddy cultivation, have **labour-intensive subsistence economies**.
- **Paddy cultivation and plantation agriculture** require more labour, and this agricultural system minimises couples living apart, leading to more children and additional hands for work.

Social Factors

❑ **Religion:**

- Religion is considered both a **promoting and a demotivating factor** for population growth.
- In many developing countries, religion acts as a promoting factor, contributing to **rapid population growth**.
- **Traditional societies** with Islamic, Hindu, and Animist religions tend to experience rapid population growth.
- **Early marriage**, child marriage, traditional social values, and illiteracy, especially female illiteracy, are factors contributing to population growth.

❑ **Demographic Factors:**

- **High Infant Mortality Rate (IMR)** is common in African countries, where couples may have more children due to uncertainty about child survival.
- **Large-sized countries** like India and China with large populations exhibit a substantial fertile group of the population.

❑ **Politico-Administrative Factors:**

- **Countries with political and administrative determination** have succeeded in controlling population growth (e.g., China, Thailand, Indonesia, Egypt, Bangladesh).
- **China's one-child policy** is an example of an administrative factor.
- **Historical events** such as partition and post-war outmigration of Jews are examples of politico-administrative factors affecting population growth.
- **Lack of health facilities** and HIV-related deaths in countries like Botswana impact population growth.
- **Emigration of people** from Spain and Portugal to South America is influenced by politico-administrative factors.

IGNITE YOUR MIND

Population Control Quandary: Should governments intervene in population growth? Explore the ethical and practical challenges of such policies.

THEORIES OF POPULATION GROWTH

Population dynamics, a focal point for scholars, demographers, and policymakers, is elucidated through various key theories:

❑ **Malthusian Theory:**

- By Thomas Malthus (1798).
- Population grows exponentially, surpassing resource growth, leading to crises.

- **Demographic Transition Theory:**
  - Mid-20th century by Frank Notestein.
  - Describes the transition from high to low birth and death rates during societal development.
- **Epidemiological Transition Theory:**
  - Developed by Abdel Omran (1970s).
  - Focuses on disease pattern shifts during demographic transitions.
- **Dependency Ratio Theory:**
  - Addresses economic implications of population structure.
- **Marxist Theory:**
  - Rooted in Karl Marx's works.
  - Links population growth to economic structures and class relations.
- **Fertility Transition Theory:**
  - Explains declining fertility patterns.
- **Optimum Population Theory:**
  - Proposed by economists like David Ricardo.
  - Suggests an ideal population size for economic well-being.
- **Neo-Malthusian Theory:**
  - Modern Malthusian interpretation.
  - Highlights environmental consequences of unchecked population growth.

These theories enrich our comprehension of population dynamics, integrating social, economic, and environmental factors.

Let us discuss some important theories in detail.

Malthusian Theory

The Malthusian Theory of Population revolves around the notion of **population growth outpacing food production**. It was formulated by **Thomas Robert Malthus,** who suggested that measures like preventive and positive checks could help maintain a **balance between population growth and food resources.**

- The theory predicts that as **population increases geometrically, the food supply increases arithmetically. Thus the pace of food supply won't match the pace of population growth,** resulting in various adversities such as illness, hunger, strife, and calamity.

- Thomas Robert Malthus (1766-1834) pioneered the **study of population statistics**.
- His ideas marked a turning point in the history of population theory by highlighting the **connection between demographics and social change**.

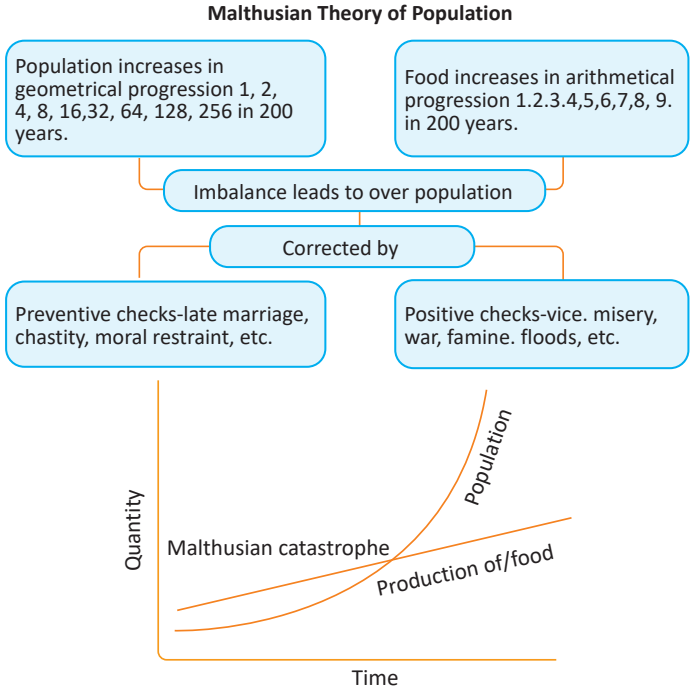

Malthusian Theory of Population
Population increases in geometrical progression 1, 2, 4, 8, 16,32, 64, 128, 256 in 200 years.
Food increases in arithmetical progression 1.2.3.4,5,6,7,8, 9. in 200 years.
Imbalance leads to over population
Corrected by
Preventive checks-late marriage, chastity, moral restraint, etc.
Positive checks-vice. misery, war, famine. floods, etc.
Quantity
Population
Malthusian catastrophe
Production of/food
Time

Fig. 5.3: Malthusian Theory of Population

- Malthus observed that human reproduction was **outpacing the ability to increase sustenance from the land**.
- He **argued that** if population growth remained unchecked, it would increase exponentially while sustenance would only increase linearly.
- In essence, Malthusian theory suggests that **population growth should be regulated based on available sustenance**.
- Unless **significant and clear limits are imposed**, the population will naturally expand as sustenance improves.
- These **limits, including** moral restraint, vice, and suffering, act as checks to keep population growth in line with sustenance levels.

Malthusian Theory - Major Elements

- **Population and Food Supply**
  - **Population Boom:** Population increases exponentially (like doubling every 25 years).
  - **Limited Food:** Food supply grows linearly (much slower than population).
  - **Unsustainable Future:** Eventually, food won't keep up with population, leading to:
    - **Food Scarcity:** Food supply depletes due to high demand.
    - **Population Checks:** Disease, famine, and war may naturally limit population growth (harsh but effective).
- **Checks on Population**
  - When population growth surpasses food production, an **imbalance occurs**.
  - **Consequently**, individuals suffer from insufficient food leading to fatalities.

- **Malthus attributes** adversities like plagues, wars, and famines to natural checks.
- Conversely, **preventive measures**, managed by humans, also exist to curb population growth.
- Malthus observes an **inverse relationship between positive and preventive checks**, with one being more successful than the other.
- Despite **differences in effectiveness**, communities universally employ some form of these checks.
- Malthus contends that despite these measures, inadequate food production relative to population growth **consistently leads to overpopulation**.

❑ **Positive Checks**

- **Nature employs** its own mechanisms to regulate burgeoning populations, adjusting them to match available food resources.
- **Positive checks**, such as famines, earthquakes, floods, diseases, and wars, are instances of nature's intervention to curb population growth.
- When population growth spirals beyond control, **nature intervenes to restore balance**.

❑ **Preventive Checks**

- **Practices like** delayed marriage, self-discipline, and living modestly contribute to maintaining equilibrium between population growth and food availability.
- These **strategies not only restrict population growth** but also offers potential to minimise the adverse effects of natural checks.

❑ **Malthusian Trap**

- The **Malthusian Trap posits** that advancements in agriculture, leading to increased food production, paradoxically result in higher population levels.
- This **cycle occurs** because the growing population demands more agricultural space, ultimately causing food shortages.
- Despite technological progress typically enhancing per capita wealth, Malthus argues that these **gains are nullified by simultaneous population growth**.
- When population exceeds the capacity of food production, a **Malthusian catastrophe ensues**, characterised by widespread famine and disease.
- Consequently, the population reverts to previous levels as a means of mitigating the crisis.

Malthusian Theory: Criticism

Western Europe witnessed rapid **population growth** with advances in **food technology**. Unlike Malthus's predictions, the United States showcases abundant **food production** with minimal agricultural employment. **Globalization** expanded food access globally, challenging Malthus's land scarcity idea. Malthus's projections on **population growth rates** were surpassed by technological and socioeconomic changes. Critics fault him for neglecting these factors and underestimating modern agriculture's capacity. Traditional Malthusian "positive checks" like **famine** are rare today, thanks to innovations. Malthus was overly pessimistic, overlooking **human innovation** and biological limits on **population growth**.

Malthusian Theory - Applicability

Malthusian theory, while not directly applicable to **Western Europe**, influenced global **population management**. Widespread use of preventative measures like **delayed marriage** and **contraception** highlights its relevance. Although not applicable in its birthplace, Malthusian principles influence two-thirds of the world, excluding **Japan** but including **Asia**, **Africa**, and **South America**. Nations like **India** embrace state-sponsored **family planning**. Developing nations align with Malthusian principles, facing challenges of high **birth rates**, **population growth**, and **poverty alleviation**. The concept applies universally, transcending racial and geographical boundaries. Despite debates, the Malthusian theory remains resilient.

In conclusion, Malthus posited that population control could be **achieved through a combination of preventative and positive measures** to align food supply with population levels, potentially averting a Malthusian catastrophe. Thomas Robert Malthus (1766-1834) played a **crucial role in advancing population studies**, introducing a seminal population theory that marked a significant milestone in demographic thought. He established a **foundational connection** between demographics and societal change.

IGNITE YOUR MIND

Can we feed a growing population sustainably? Explore the challenges of food security, climate change, and agricultural innovations amid rising population. What role can technology and responsible consumption play?

Demographic Transition Theory

The **demographic transition theory** examines the link between **economic progress** and **population dynamics**, analyzing shifts in **birth** and **death rates** as well as overall **population growth** across **development stages**. It predicts that as societies advance from **rural** and **low-literacy settings** to **urban, industrialized, and higher-literacy environments**, they move from **high birth and death rates** to **lower ones**.

Key Points

❑ Introduced by **Warren S. Thompson** in **1929** and popularized by **Frank W. Notestein** in **1945**, the theory explains changes in **births, deaths, and population growth** in **industrialized societies**, starting in the **late 18th century**.

❑ It's a general description of the evolutionary process rather than a strict rule for **population expansion**, aiming to elucidate fundamental principles of **human population evolution** due to **industrialization**.

- Widely recognized as a useful tool for depicting a nation's **demographic history**.
- Conceptualized as a **five-stage process**, with declining **fertility preceding mortality decline**, eventually reaching **equilibrium**.
- The **socio-economic** and **demographic transformations** of society occur **concurrently**.
- Identifies stages like **pre-transition** (high and erratic birth and mortality rates), **Stage I** (rapid population growth), **Stage II** (slow population growth), and **Stage III** (significant decline in both birth and mortality rates, resulting in **zero population growth**).
- **Pre-industrial cultures** are characterized by **stable populations** with **high mortality and birth rates** limiting growth.

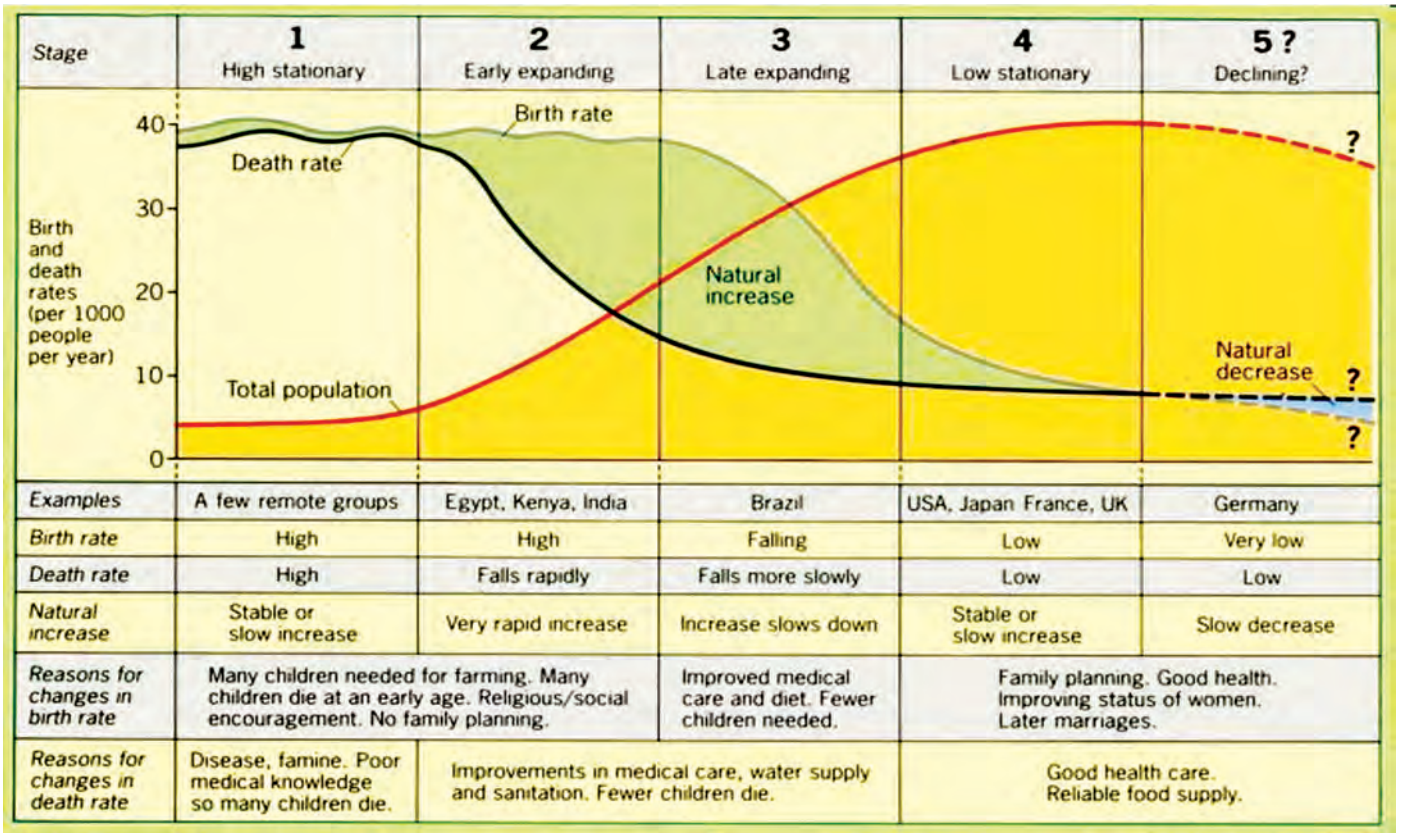


Fig. 5.4: Demographic transition theory - Stages

Stages of Demographic Transition

First Stage: Low Economic Development

- **Low economic development** with agriculture as the primary income source.
- **Poor living conditions** due to limited medical services, diseases, famines, and high illiteracy.
- **High death rates** and elevated birth rates; population stability with a young, religiously dominated society.
- **Examples**: **Sierra Leone** and **Somalia**.
- **Drivers**: High **fertility** and **mortality** due to diseases and food scarcity.

Second Stage: Rapid Population Growth

- Population explosion with **high birth rate** and **low death rate**.
- **Economic expansion** and rising income.
- **Declining mortality** due to improved healthcare and nutrition.
- Persistent high birth rate despite declining mortality.
- Youthful population, significant **teenage demographic**.
- **Transition**: Gradual decrease in **fertility**, substantial net population gain.

Third Stage: Low Population Growth

- Low growth due to declining **birth** and low mortality rates.
- **Economic progress** triggers urbanization and shifts in family size perception.
- Slowing population growth with **India** as an example.
- **Characteristics**: Stabilized population pyramid, declining birth and fertility rates, increasing **life expectancy**.

Fourth Stage: Population Stability

- **Stable population** with low birth and death rates.
- **Economic prosperity** and improved quality of life.
- Emphasis on family size for quality rather than quantity.

- **Characteristics**: Contracting population pyramid, stable or sluggish growth, low birth and death rates, increased life expectancy.

Last Stage: Decline in Fertility and Mortality

- **Declining fertility** and mortality rates.
- Stable or steady population growth with **urbanization** and technological advancement.
- **Intentional family planning**, smaller family sizes.
- Human adaptability is evident in adjusting fertility rates.
- **Global Demographic Transformation**: Diverse patterns and trends among nations.

Criticism

- The **demographic transition concept** faces criticism for not qualifying as a true theory.
- The sequence of transition stages is not always **chronological**.
- Former **USSR nations, excluding Russia**, saw mortality rate increases, challenging the expected progression.
- Relies heavily on data from **Europe, America, and Australia**, limiting its global applicability.
- Lacks **predictive power** and presents stages as inevitable, disregarding critical variables.
- **Technological advancements**, especially in medicine, significantly impact **death rate trends**.
- Fails to explain **fertility decrease**; no specified **time frame** for progression through stages.
- Emerging countries with rapid population growth due to declining death rates are not well addressed.
- Despite flaws, the theory provides a broad understanding of **global demographic history**.
- The transition process for each nation is a generalization derived from **Western demographic trends**.

In conclusion, demography is characterised by its **emphasis on quantification** rather than theoretical frameworks. Nevertheless, it has produced one of the most extensively documented generalisations in the social sciences: the demographic transition. This **hypothesis explores** the correlation between economic development and population dynamics, analysing shifts in birth and death rates alongside population growth rates within the context of growth and development.

IGNITE YOUR MIND

Demographic Domino Effect: Developed nations shrink while developing nations surge. Can this demographic divide be bridged, or will it widen global inequalities? What are the ripple effects of population changes, from resource scarcity to climate change? Can we predict and manage these impacts?

Optimum Population Theory

The optimal population refers to the **population size,** that when considered alongside a nation's available resources and production methods, results in the **maximum per capita return** or revenue. Confucius initially introduced the concept of optimal population, while Edwin Cannan elaborated on it in his book "Wealth" (1924), presenting the theory of population optimum. This hypothesis gained popularity through the works of Robbins, Carr-Saunders, and Dalton.

- Introduced by **Confucius** and further developed by **Edwin Cannan** in "Wealth" (1924).
- Gained popularity through works of **Robbins, Carr-Saunders, and Dalton**.
- **Key Points**
  - **Optimal population** is determined by the size generating the highest **income per capita**.
  - Deviation decreases **income per capita**.
  - Each country has a specific population maximizing **per capita income**.
  - Deviation reduces **per capita income**.
  - Population growth associated with increased **per capita income** indicates **underpopulation**.
  - **Overpopulation** refers to excess of population in an area in relation to the available resources and technology.**Overpopulation** occurs when growth leads to decreased **per capita income**.
  - **Optimal population** point signifies peak **per capita income**.
- **Factors Influencing Optimal Population**
  - **Optimal population** fluctuates with changes in **production elements** and **techniques**.
  - Improvements in **manufacturing methods** increase **output per person**.
  - **Natural resource growth** raises the **optimal population level**.
  - Changes in **production methods** or **resources** alter **optimal population size**.
  - Permanent **optimal population** establishment is impossible due to evolving productive elements and techniques.
- **Over-Population**
  - Excess individuals surpass **resource capacity**.
  - Results in decline in **average productivity**, lower **per capita income**, and deteriorated living standards.
  - Consequences include **food scarcity**, increased **sickness**, strain on **resources**, and various forms of **unemployment**.
- **Under-Population**
  - Population falls below **optimal level**, leading to inadequate resource utilization. It occurs when a country's population has declined too much to support its current economic system.
  - Prevents capitalizing on **economies of scale**.

- Increasing population in such instances leads to a rise in **per capita income**.

❑ **Postulations:**
- **Natural resources** change over time.
- **Production methods** are static.
- **Capital** remains unchanged.
- **Behaviors** and **preferences** stay constant.
- Working-age ratio remains steady with **population growth**.
- **Working hours** remain constant.
- **Business organizational structures** stay consistent.

❑ **Dalton's Formula**
- Mathematical representation for **overpopulation** and **underpopulation**.
- **Maladjustment** calculated as M = ((A – O) / O). O denotes ideal population level and the A denotes actual population-level.
- If M exceeds one, **overpopulated**; if below one, **underpopulated**.
- M equals zero at **optimal population**.

❑ **Examples**
- Despite its high population, the **United States** doesn't face **overpopulation** issues.
- Saharan nations experience **overpopulation** due to inefficient **resource utilization**.
- **Singapore** effectively manages high population density by efficient **resource utilization**.

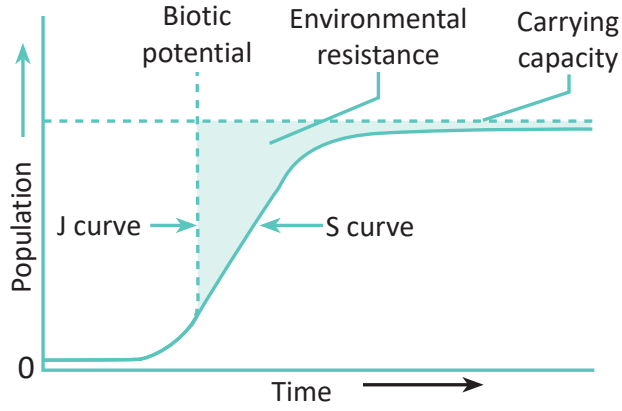
❑ **Superiority over Malthusian Theory**
- Universally applicable regardless of **economic circumstances**.
- Associates population issue with both **agricultural** and **industrial sectors**.
- **Dynamic**, allowing **per capita income** increase over time due to advancements.
- Optimistic and pragmatic outlook toward **population challenges**.

❑ **Criticism**
- Lack of **empirical evidence** supporting **optimal level** existence.
- Determining **optimal level** is challenging.
- Accuracy issues in calculating **per capita income**.
- Overlooks **per capita income distribution**.
- **Optimal level** varies over time.
- Disregards **social** and **institutional contexts**.
- Government policies do not accommodate the theory.
- Fails to elucidate factors influencing **population growth**.

In conclusion, the concept of **optimal population refers** to the ideal population size that best aligns with a country's available resources and technological level, **resulting in maximum income per capita**. It represents the **most desirable population size for a country**.

WORLD POPULATION GROWTH: A COMPREHENSIVE JOURNEY

The analysis of **human population growth** spans 10,000 years, marked by two significant accelerations:



J shaped and S shaped growth curves

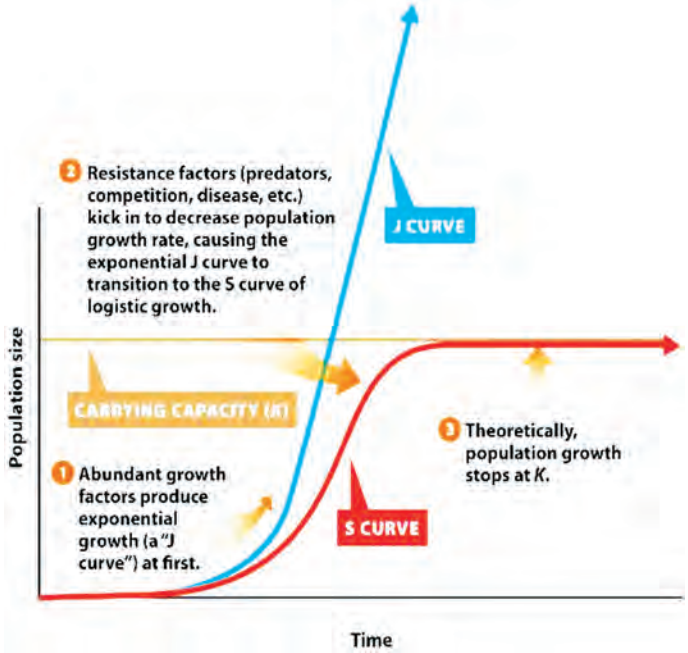

2 Resistance factors (predators, competition, disease, etc.) kick in to decrease population growth rate, causing the exponential J curve to transition to the S curve of logistic growth.
J CURVE
CARRYING CAPACITY (K)
3 Theoretically, population growth stops at K.
1 Abundant growth factors produce exponential growth (a "J curve") at first.
S CURVE
Population size
Time

Fig.5.5: J shaped and S Shaped Growth Curves

1. **Agricultural Revolution (8000 BC):** Initiated **plant and animal domestication**, stabilizing food supply and enhancing resilience.
2. **Industrial Revolution (mid 18th century):** Fueled by **fossil fuels** and **steam engines**, it transformed societal structures and facilitated global travel.

These revolutions significantly influenced worldwide **population patterns**. Until the 1750s, there was stability in population growth. From the 1750s to the 1950s, there was a slight increase in population. Post-1950s, there was exponential growth, represented by a J-Curve, which then transitioned into an S-Curve with each phase stimulating technological advancements. Known as the **Neo-Malthusian Approach**, featuring 'S' curves symbolizing the **Green Revolution**, **Medical Revolution**, and **IT Revolution**.

Analysis of Population Growth Segments:

1. **10,000 BC to the 20th Century Overview:**
   - **Estimated Population (8000 BC):** Approx. 5 million people.
   - **Roles of Men and Women:** Men engaged in **hunting**, while women contributed to the food supply through **plant gatherings**.
   - **Population Density:** Relatively low, with approximately 4 persons per square kilometer.
   - **Birth and Death Rates:** Witnessed high **birth** and **death rates** during this period.

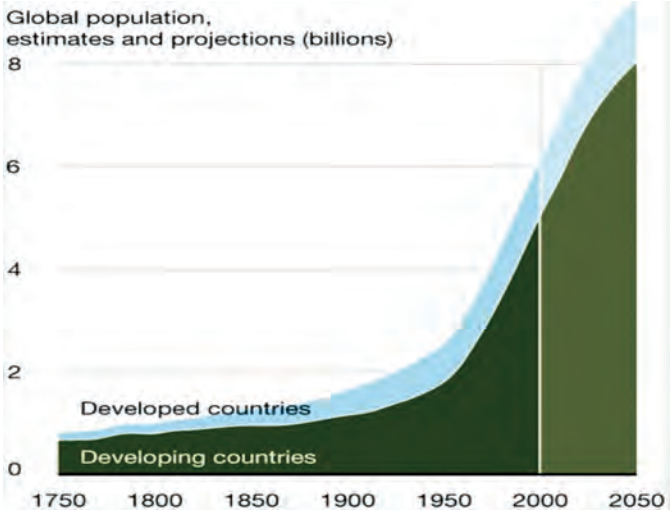


Fig. 5.6: Population size since 1750s.

2. **Agriculture Revolution (circa 8000 BC):**
   - **Impact on Death Rate:** Led to a decrease in the death rate due to an enhanced food supply, improved nutrition, and increased longevity.
   - **Agriculture and Natality:** Agriculture and high **natality** were interconnected, with economic value associated with having more children in farming families.
   - **Total Population Growth:** The global population around the time of Christ was estimated to be between 200 to 300 million, surging to 500 million by 1650 AD.
3. **Medieval Period Overview:**
   - **Economic Emphasis:** Heightened focus on **trade** and **commerce** resulted in the growth of cities and towns and an upsurge in the demand for consumer goods.
   - **Agricultural Transformation:** Landowners expressed a desire to utilize more land for **agricultural purposes**, transforming agriculture into a significant business.
4. **Industrial Revolution Impact:**
   - **Systemization of Production:** Power-driven machines led to the systematic organization of production, resulting in high per capita output and the accumulation of wealth through the growth of secondary and tertiary activities.
   - **Urbanization Challenges:** Population migration from rural to urban areas led to poor living conditions and elevated death rates in urban areas, particularly due to epidemics like **cholera**.
5. **Last Century's Unprecedented Growth Factors:**
   - **Medical Advancements:** Growth fueled by the advancement of medical services, controlling the death rate and contributing to improved overall health.
   - **Life Expectancy Transformation:** Significant shift in **life expectancy**, e.g., from 23 years in 1901 to 64 years in 2001 in India.
   - **Increased Food Supply:** General technological progress contributed to a rise in **food production**, meeting the demands of the growing population. Examples include the **Green Revolution** and advancements in **Biotechnology**.
   - **Education Impact on Birth Rates:** Despite technological advances, **educational shortcomings** have hindered changes in social attitudes toward birth. **Birth rates** remain influenced by social factors, connecting this biological phenomenon to conditions like **religion**, **beliefs**, and **traditions**.
6. **Information and Computer Technology (ICT) Revolution Impact:**
   - **Ease of Life:** The evolution of **ICT** has significantly simplified daily life, making various tasks easier to perform.
   - **Controlled Population Increase:** The accessibility and availability of information through **ICT** have played a role in the controlled increase of the human population in the contemporary era.

Contemporary Population Dynamics:

- **Observation:** The notable rise in population is predominantly observed in **developing nations**, where 75% of the overall population is centered.
- **Timeline:** While Western Europe experienced a surge in population during the 1750s, **developing countries** encountered a similar phenomenon in the 1950s.

Present Trend of Population Growth

The overall global population growth rate is **currently fell below 1 per cent per year** (According to **World Population Prospects):** However, it's crucial to understand that this is a global average and that the rate varies significantly between regions and even individual countries. The current trend can be studied through:

- Population growth regional patterns in developed nations.
- Population growth regional patterns in developing nations.

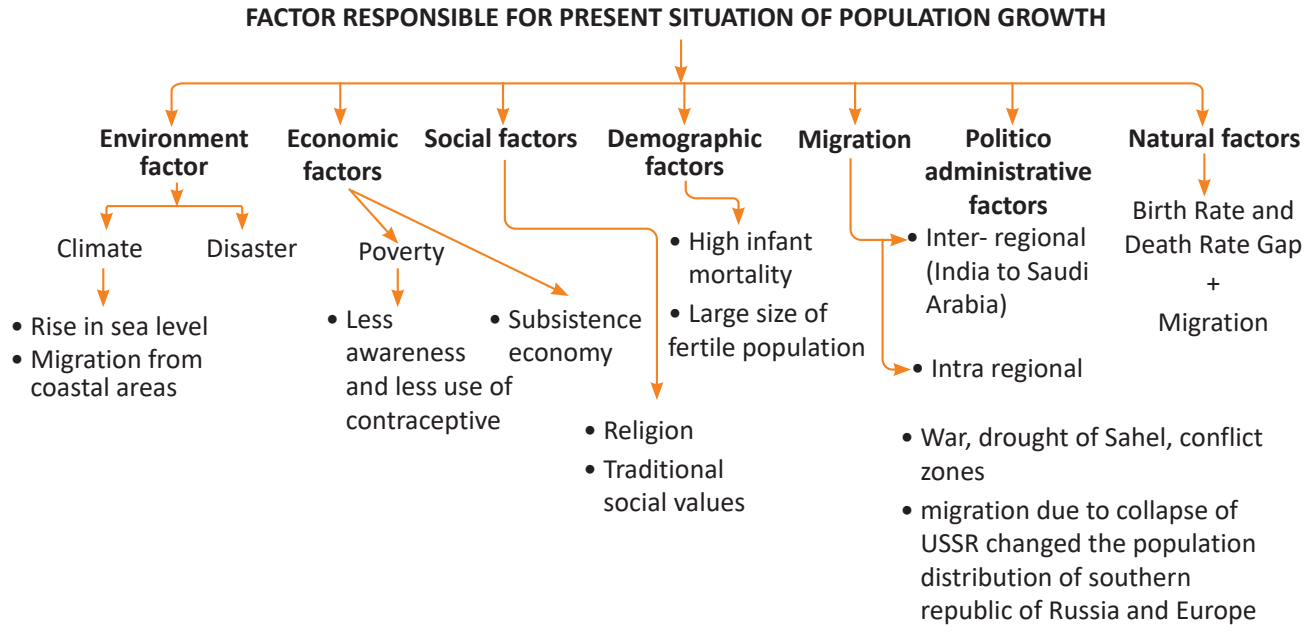

FACTOR RESPONSIBLE FOR PRESENT SITUATION OF POPULATION GROWTH
Environment factor
Economic factors
Social factors
Demographic factors
Migration
Politico administrative factors
Natural factors
Climate
Disaster
Poverty
• Rise in sea level
• Migration from coastal areas
• Less awareness and less use of contraceptive
• Subsistence economy
• High infant mortality
• Large size of fertile population
• Religion
• Traditional social values
• Inter- regional (India to Saudi Arabia)
• Intra regional
• War, drought of Sahel, conflict zones
• migration due to collapse of USSR changed the population distribution of southern republic of Russia and Europe
Birth Rate and Death Rate Gap
+
Migration

Fig. 5.7: Factors influencing Population Growth

Population growth regional patterns in developed nations.

The general trend of population growth in developed countries is slowing down, and in some cases, it is even negative.

- **Average growth rate:** The average annual population growth rate in developed countries stands at 0.5%, significantly lower than the global average of 1.1%.
  - Some countries like Japan and Italy are experiencing **negative growth rates**.
- Migration stands out as the primary contributor to the increase in population. **Edward Alsworth Ross**, a sociologist, coined the term "race suicide" to express concerns about declining birth rates among certain racial or ethnic groups.
- Race-based immigration restriction was justified by what came to be called "race suicide. **In developed countries**, population growth manifests in three patterns: **Positive Growth, Stagnation, and Negative Growth**.

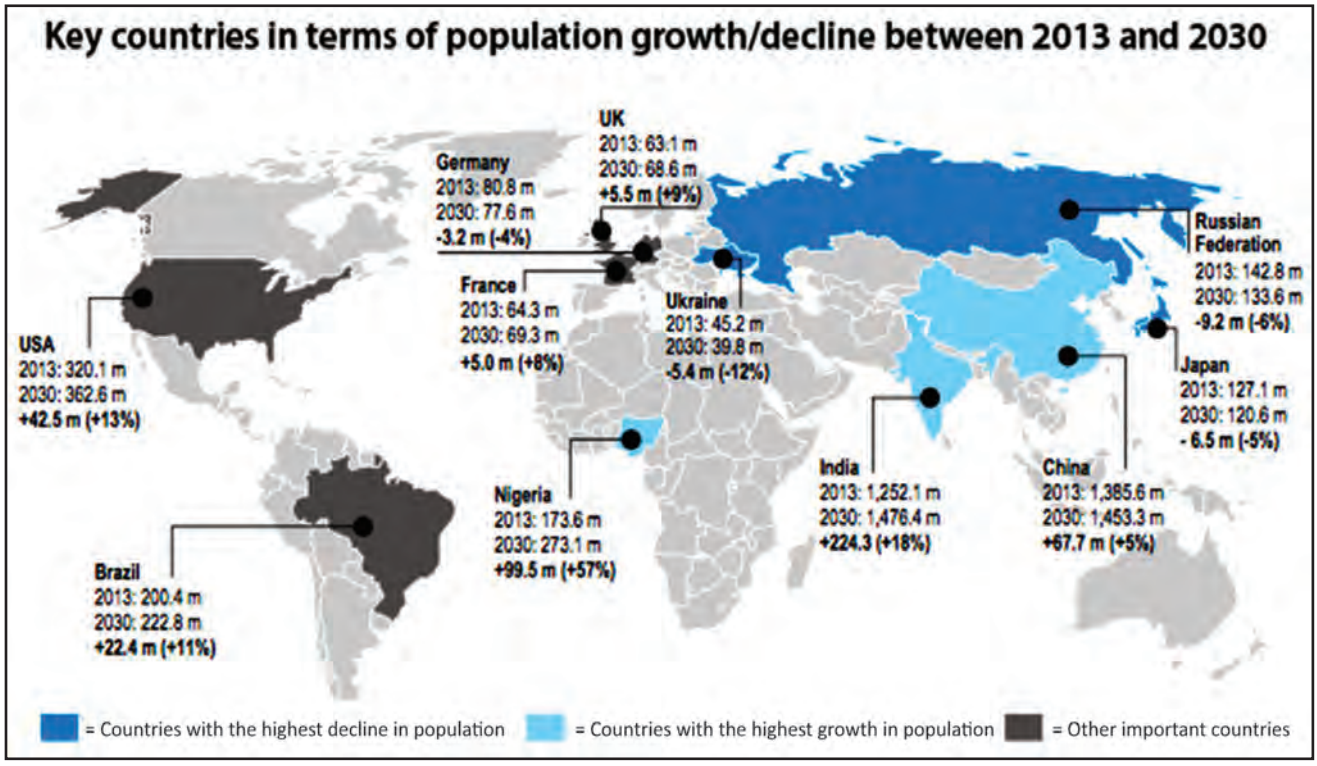
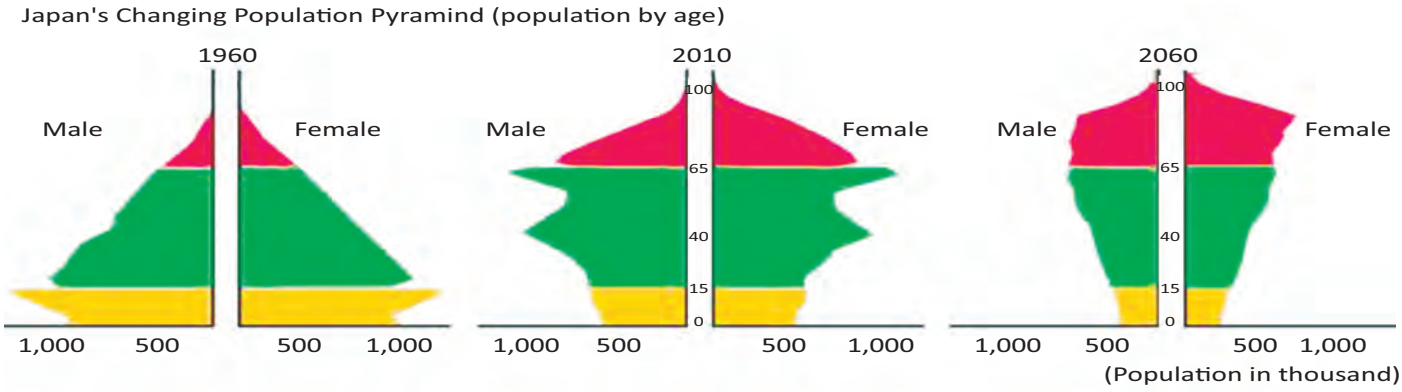


Fig. 5.8: Patterns of Growth

Challenges of Low Population Growth

- **Age Pyramid Inversion:** Low population growth results in long-term demographic problems, leading to the inversion of age pyramids.
- **Ageing Population:** Developed countries face the challenge of an ageing population, where individuals over 65 years outnumber those under 25 years. E.g., The population aged 0-14 in Japan accounts for 11.3% of the total population and the population aged 65 and over in Japan accounts for 28.7% of the total population (World Bank Data).

Japan's Changing Population Pyramid (population by age)



Sources: (For 1960 and 2010) Statistics Bureau (Ministry of Internal Affairs and Communications), Population Census of Japan; (for 2060 projection) National Institute of Population and Social Security Research, Population Projections for Japan (January 2012), based on medium-variant fertility and mortality assumptions.

Fig. 5.9: Population Projection for Japan

- **Labour Shortage:** There is a scarcity of labour as job opportunities outnumber the available workforce.
- **School Closures:** Institutions may face closures due to economic challenges arising from low population growth.
- **Government Focus on Social Services:** Governments may need to allocate more resources to social services due to an ageing population, impacting other sectors.
- **Migration Liberalisation:** Some countries may resort to liberalising migration laws to address labour shortages.
- **Pluralistic Societies:** Low population growth can contribute to the emergence of pluralistic societies, introducing unique sets of challenges.

Measures Adopted by Developed Countries to Address Low Population Growth

- **Legal Recognition of Pre-Marriage Babies:** Some countries provide legal recognition to children born before marriage Examples include France, Denmark, Iceland, and Sweden.
- **Promotion of Adoption:** Encouraging adoption is a strategy, with countries like Thailand serving as major child adoption markets for developed nations, particularly Norway and Sweden.
- **Marriage Age Relaxation:** Certain countries have relaxed marriage age requirements, as seen in Scotland where the marriage age system has been completely abolished.
- **Establishment of Baby Care Centers:** The development of baby care centres supports families in managing childcare responsibilities.
- **Government Incentives:** Governments offer incentives such as promotions, salary increments, and housing facilities to encourage family planning and childbirth.
- **Controlled In-Migration:** Some countries limit in-migration, modifying policies to attract diverse populations. For instance, the White Australia Policy has been adjusted to encourage the migration of individuals from black and coloured communities.

Pattern of Population Growth in Developing Countries

Developing nations are marked by rapid population growth, and within this category, four growth patterns can be identified:

- **Explosive Growth (GR > 3%):** Exemplified by African countries like Nigeria and Uganda.
- **Rapid Growth (GR is 2-3%):** Notable examples include Pakistan, Maldives, and Nepal.
- **Moderate Growth (GR is 1-2%):** Countries such as India and Egypt fall into this category.
- **Slow Growth (GR is 0-1%):** Represented by nations like Argentina and China.

- Although **sizable countries like** India, Indonesia, Nigeria, Bangladesh, and Brazil have managed to significantly reduce their growth rates, they still **experience a substantial absolute increase** in population.
- The **population pyramid in developing countries** is characterised by a demographic bulge, with large bottom and mid-blocks.

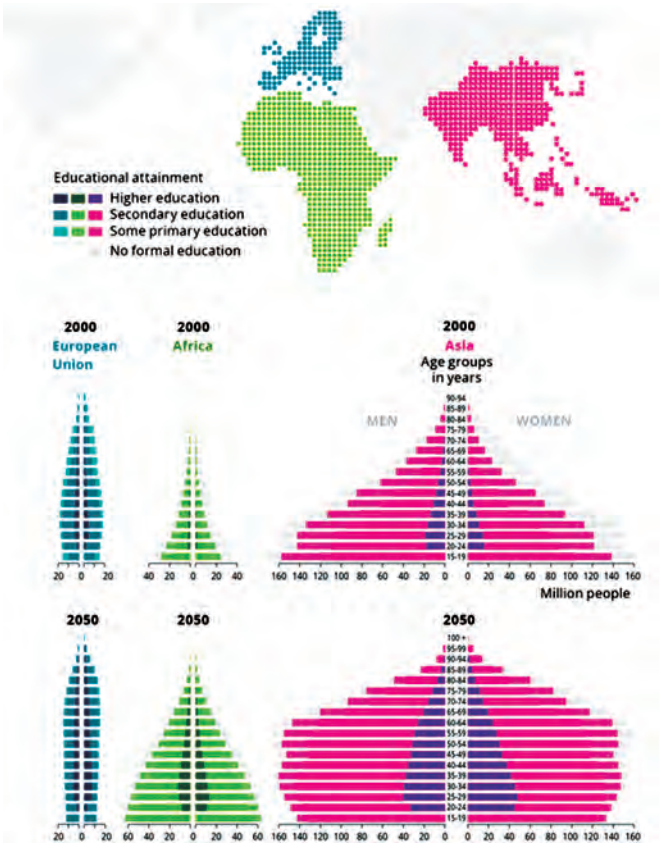


Fig. 5.11: Population pyramid in developing countries

Developing countries are considered the primary contributors to the global population explosion. As stated by **Ashok Mitra**, "these are the countries whose real problem is an increased fertile group of the population."

Issues Arising from Rapid Population Growth

- **Education, Food, and Housing Challenges:**
  - **Ensuring proper** education, food, and housing becomes a significant challenge.
  - Potential genetic deterioration of humankind.
  - **Contributes to a poor and unhealthy society,** leading to issues such as child trade and child labour.
- **Workforce and Unemployment:**
  - An increased workforce may result in higher unemployment rates.
  - Elevated unemployment can lead to a rise in poverty, illiteracy, and reliance on subsistence economies.
  - This, in turn, fuels social problems like increased crime, mental retardation, and political instability.
- **Dependent Population Rise:**
  - A surge in the dependent population places a strain on resources, with significant expenditures on health, housing, and education.
- **Food and Nutrition Challenges:**
  - While the world has enough food for basic survival, there is a shortfall for ensuring healthy survival, contributing to a hidden hunger problem.
- **Economic Backwardness and Illiteracy:**
  - Rapid population growth exacerbates economic backwardness and illiteracy.
- **Urbanisation and Slums:**
  - The rapid growth of urbanisation and the emergence of slums become pressing concerns.
- **Environmental Degradation:**
  - Over-exploitation of resources and environmental degradation are intensified due to population pressure.
- **Global Population Statistics:**
  - The global population has exceeded 8 billion in 2022.
  - The projected year for global population stability is 2200.
  - According to the United Nations Population Fund data, India has surpassed China to become world's most populous nation with 142.86 crore people(as in April 2023).

POPULATION MANAGEMENT PROBLEMS				
Social	**Economic**	**Demographic**	**Administrative problem**	**Environment**
❑ Food and nutrition ❑ Housing ❑ Education ❑ Child trade ❑ Child labour ❑ Poverty ❑ Unemployment ❑ Increased crime ❑ Social unrest ❑ Illiteracy	❑ Economic backwardness ❑ Illiteracy ❑ Unemployment ❑ Poverty	❑ High IMR ❑ High MMR ❑ High Density	❑ Law and order problem ❑ Riots ❑ Child trade ❑ Child labour	❑ Growth of slums ❑ Environment degradation ❑ Over exploitation of resources

IGNITE YOUR MIND

Birthquake or Bust?: With declining birth rates in developed nations and rapid growth in developing ones, are we heading for a global demographic imbalance? Will this create opportunities or spark future conflicts? How can we manage this shift for a sustainable future?

WORLD POPULATION DISTRIBUTION

Population distribution refers to the **spatial arrangement of human settlements** across a geographical area. It describes how people are **spread out or concentrated** in different locations, and the factors influencing these patterns.

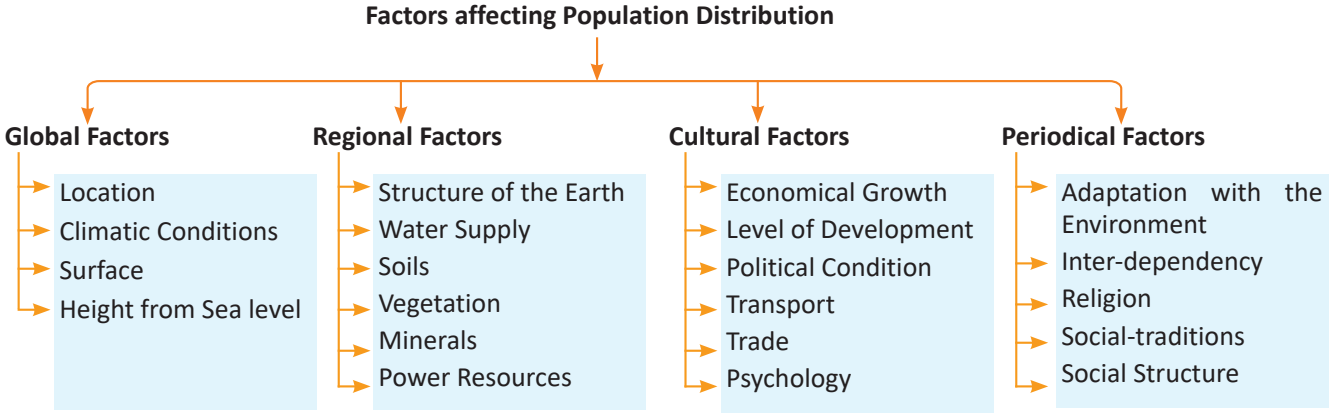


Fig. 5.11: Factors affecting Population Distribution

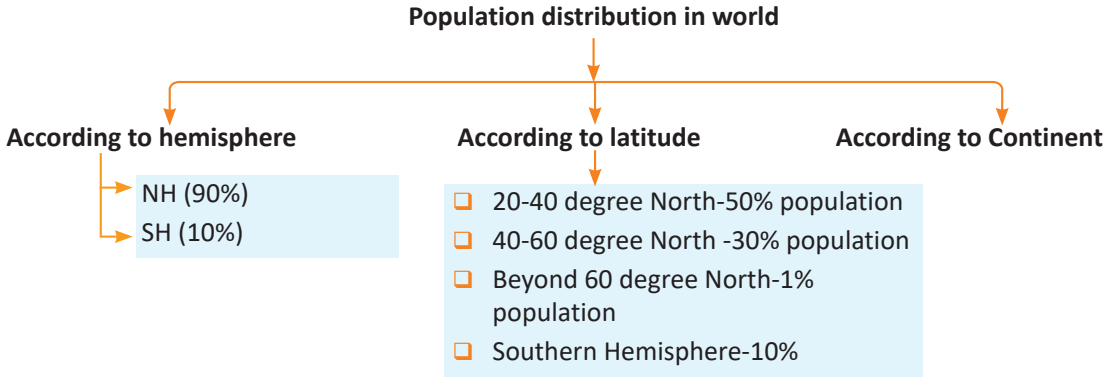


Fig. 5.12: Spatial Distribution of Population in the World

Geographical Distribution Factors

- Population **distribution is uneven** and related to geographical factors.
- **According to Clark**, "A few regions have human agglomerations while the vast area is void gone."
- **Cressey stated**, "A few areas have many people and many areas have a few."
- There is a significant uneven distribution, with **90% of the world's population** residing north of the Equator and **10% south of the Equator**, as noted by Clark.

IGNITE YOUR MIND

Empty Deserts, Bustling Coasts: Why do people cluster in certain areas, leaving vast regions sparsely populated? Explore the push and pull factors shaping this uneven distribution.

Population distribution based on latitude

- **Majority Concentrated Between 20-40 Degrees North**: Approximately 50% of the global population resides in the geographical band between 20 and 40 degrees north latitude.
- **Diverse Climates:** This region experiences a variety of climates, including monsoonal, Mediterranean, East Coast, West Coast climates, and grasslands.
- **Moderate Population Between 40-60 Degrees North:** Around 30% of the world's population is distributed in the area between 40 and 60 degrees north latitude.
- **Sparse Population Beyond 60 Degrees North:** To the north of 60 degrees latitude, only 1% of the global population resides, indicating a significantly lower population density in these northernmost areas.

Population Distribution on Continental basis

- **Asia:** The Asia and the Pacific region is home to 60 per cent of the world's population – some 4.3 billion people – and includes the world's most populous countries, China and India, their ancient civilizations and fertile lands acting as magnets for human settlement.

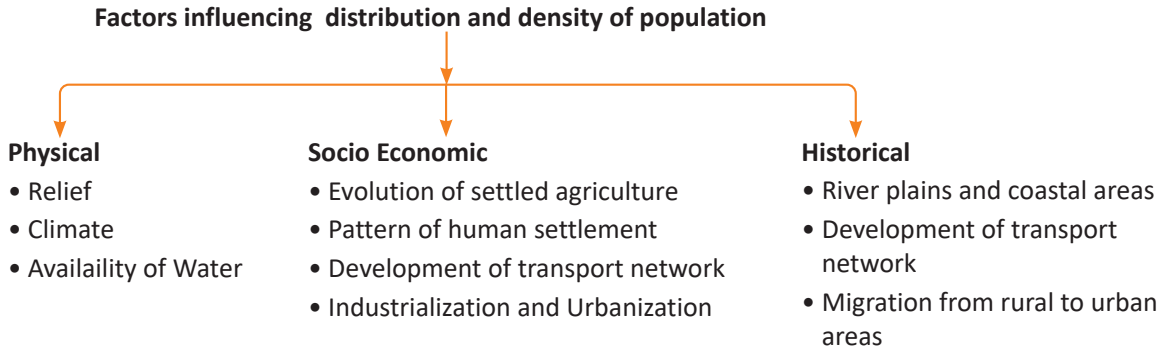

Factors influencing distribution and density of population
Physical
• Relief
• Climate
• Availaility of Water
Socio Economic
• Evolution of settled agriculture
• Pattern of human settlement
• Development of transport network
• Industrialization and Urbanization
Historical
• River plains and coastal areas
• Development of transport network
• Migration from rural to urban areas

Fig. 5.13: Causes of uneven distribution of population

- **Africa:** Following closely behind is Africa, with around 18% of the global population. Rapid urbanisation and a youthful demographic are propelling the continent's population growth.
- **Europe:** With around 10% of the world's population, Europe's story is one of historic population booms and present-day stabilisation. Densely packed cityscapes and ageing populations define the continent's demographic landscape.
- **Americas:** North and South America together house roughly 9% of the global population. While the vast Amazon rainforest remains sparsely populated, urban centres like New York City and Sao Paulo pulsate with life.
- **Oceania:** The least populous continent, Oceania, is home to just around 0.5% of the world's inhabitants. Australia and New Zealand, with their vast outback and island chains, represent the majority of the continent's population.

IGNITE YOUR MIND

Planet Overload: Our Earth holds 8 billion people, but can it sustain 10 billion? Dive into the debate: Are we nearing population overload, or is technology our saviour?

Future Population Trends by Continent

Africa

- **Fact**: Between 2022 and 2050, the population of sub-Saharan Africa is expected to almost double, surpassing 2 billion inhabitants by the late 2040s. (**Source:** UN, World Population Prospects 2022)
- **Figure:** Sub-Saharan Africa's population could double by 2050, reaching 2.4 billion. (**Source**: World Bank, Africa's Pulse, Issue 24 October 2023)
- **Reasons:** High fertility rates (average 4.6 births per woman), young population structure, and potential decline in mortality. (**Source:** Our World in Data, Population Growth)
- **Challenge:** Providing resources, infrastructure, and employment for a rapidly growing population.

Asia

- **Fact:** Currently the most populous continent with 4.6 billion people, home to India (1.4 billion) and China (1.44 billion). (**Source:** UN, World Population Prospects 2022)
- **Figure:** Population expected to peak around 2050 at 5.3 billion and then slowly decline. (**Source:** UN, World Population Prospects 2022)
- **Reason:** Declining fertility rates (average 1.7 births per woman), urbanisation, and ageing population. (**Source:** Our World in Data, Population Growth)
- **Challenge:** Addressing resource scarcity, pollution, and income inequality.

Europe

- **Fact:** Currently has 748 million people, expecting stable or declining population. (**Source:** Eurostat, Population statistics - overview)
- **Figure:** Fertility rates are below the replacement level (average 1.6 births per woman) in most countries. (**Source:** World Bank, World Development Indicators)
- **Reason:** Ageing population, low birth rates, and emigration. (**Source:** UN, World Population Prospects 2022)
- **Challenge:** Supporting ageing population, potential labour shortages, and integrating immigrants.

Americas

- **Fact:** Currently has 1.03 billion people, expecting moderate growth of 300 million by 2050. (**Source:** UN, World Population Prospects 2022)
- **Figure:** Immigration and natural increase in some countries contribute to growth. (**Source:** PAHO, Health in the Americas 2022)
- **Reason:** Diverse trends across countries, with some experiencing decline and others growth. (**Source:** Inter-American Development Bank, Social Report 2023)
- **Challenge:** Income inequality, political instability, and environmental degradation in some regions.

Oceania

- **Fact:** Currently has ~45 million people, expecting the slowest growth globally.
- **Figure:** Current population growth rate is 1.153%, which is a 1.79% decrease from 2023. By 2100, Oceania's population growth rate is projected to decrease to 0.16%.
- **Reason:** Low birth rates (average 1.8 births per woman) and small population base.
- **Challenge:** Attracting and retaining skilled workforce, and maintaining economic growth.

IGNITE YOUR MIND

Urban Divide: Smart cities, autonomous vehicles, and hyperloops promise transformation. But gaps between rich and poor widen within cities. But will these technologies benefit all, or exacerbate existing inequalities? How can we bridge the income divide, ensure affordable housing, and create equitable access to opportunity in urban spaces?

POPULATION DENSITY

Population density is the average number of individuals in a given area, crucial for assessing both overpopulation and underpopulation. Introduced by Henry Drury Harness in 1837, it facilitates comparisons and is expressed as individuals per square unit.

- There are three main types:
  - **Arithmetic Density** (total population over total area)
  - **Physiological Density** (population over cultivable land)
  - **Agricultural Density** (agricultural population over cultivated area).
  - Examples of densely populated regions include developed urban centres and parts of Asia and Europe.
- **Physiological density** reflects human pressure on land, relevant for agricultural economies like Egypt. **Agricultural density** assesses the relationship between people and cultivated land.

Distribution of Population Density in the World

The inhabitable regions of the world can be categorised into Ecumene and Non-Ecumene locations.

Factors influencing distribution and density of population

Physical
- Relief
- Climate
- Natural vegetation
- Soil

Socio Economic
- Religious/customs
- Education
- Awareness
- Per capita income
- Standard of living
- Industrialization
- Transportation
- Urbanization

Political
- Govt. policy towards population

Historical
- River plains and coastal areas
- Development of transport network
- Migration from rural to urban areas

Fig. 5.14: Factors Influencing Population Density

Global Rise of Population Density

- **1950:** Global density: ~40 people/km²
- **2021:** Global density: ~61 people/km² (World Bank)
- **Growth rate:** Slowing down, currently at ~0.91% annually

Ecumene

It refers to the inhabited or populated areas of the world, where people have established permanent settlements and developed societies. These regions typically have significant human activity, infrastructure, and civilization.

- Ecumene includes urban, suburban, and rural areas where people live and engage in various activities such as agriculture, industry, commerce, and culture.

Non-ecumene

It refers to the uninhabited or sparsely populated areas of the world. These regions have very low population densities or may be completely devoid of human habitation.

- Non-ecumene areas often include deserts, polar regions, dense forests, high mountain ranges, and remote islands.
- Due to harsh environmental conditions or geographical limitations, human settlement and development are limited or non-existent in these areas.

High population Density Region

Average population density in a given area, indicating the relationship between population size and geographical space.

Major Regions and Characteristics

- **East Asia and South Asia:** Monsoonal climate influences agriculture, Paddy cultivation sustained by seasonal monsoons, Flood plains in China, Pakistan, India, and Bangladesh support dense populations.
- **Nile Valley:** Wheat-growing region with population density exceeding 500 individuals per sq km, Fertile black alluvial soil and canal irrigation contribute to agricultural productivity.
- **West Europe, North European Plains, Anglo America, and Japan:** Highly developed regions with advanced industrialization and urbanization, Attractive for migration due to job opportunities, healthcare, and high living standards.
- **Eastern Littoral Anglo America:** High population density and urban development along the eastern coastal areas of the U.S. and Canada.
- **Metropolitan Regions Worldwide:** Vital hubs of population concentration and economic activity. Examples: Mexico City (20% of Mexico's population), São Paulo, Rio de Janeiro (15% of Brazil's population).
- **Islands and High-Density Areas:** Countries like Bahrain, Mauritius, Jamaica, Trinidad and Tobago, Hawaii Group, Puerto Rico, Attractive geographical conditions and robust economies lead to significant population concentration.

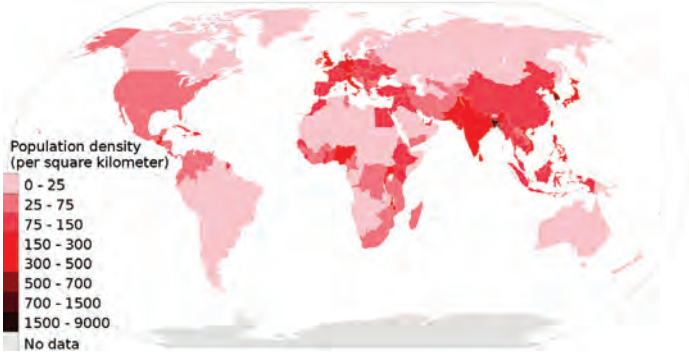


Fig. 5.15: Population Density across the World

Regions with Moderate density

Regions with moderate population density occupy a crucial **middle ground** between densely populated urban centres and sparsely inhabited rural areas, offering a balance between urban amenities and natural landscapes.

Includes

a. Savannah lands in Brazil, North Australia, and parts of Africa.
b. Plateau areas with favourable tropical climates.
c. Fertile soil regions with sub-humid conditions.
d. Equatorial regions modified by altitude.
e. Australia and New Zealand.

- **Temperate grasslands**: Some experience population growth through immigration, while others grow naturally.

Non Ecumene (Void, Sporadic)

Non-ecumene areas, often referred to as void or sporadic regions, represent vast expanses of land with **minimal human habitation or settlement**. These areas contrast starkly with the bustling activity of ecumene regions, featuring sparse population densities, uninhabited wilderness, and challenging environmental conditions.

Void zones:

These are **geographical areas** where **environmental conditions are strongly** unfavourable for population concentration, such as equatorial rainforests, tropical deserts, high mountains, and polar regions. These regions exhibit low population density and include:

Different Latitude Regions

- **Equatorial Regions:**
  - Characterised by high temperatures, abundant rainfall, high humidity, and dense vegetation.
  - Notably known for the rapid growth of vegetation, forming Selvas.
- **Selvas Distribution:** Selvas, despite their characteristics, are sparsely scattered across various locations.
- **Amazon Basin:** It is a significant low-latitude region with dense Selvas.
- **South-West Africa:** Parts of South-West Africa exhibit Selvas characteristics.
- **Zaire Basin:** It is another region with low latitude features, including Selvas.
- **Subpolar and Polar Regions (North/South of 60 degrees North):** These areas exhibit characteristics of both subpolar and polar regions, with extremely cold conditions.
- **Prolonged Cold Periods:** The average temperature remains below freezing for more than 9 months of the year.
- **Extreme Weather Events:** Cold waves, blizzards, and purges (Siberia) are common, contributing to challenging environmental conditions.
- **Limited Bacterial Activity:** The severe climate, especially in Siberia, results in low or no bacterial activity.
- **Barren Landscape:** Lack of proper soil formation and absence of vegetation characterize these regions.
- **Challenging for Human Survival:** The harsh conditions in these high latitude regions make human survival difficult.

High-Temperature Regions:

- **Temperate and Tropical Zones:** Encompass both temperate and tropical regions with consistently high temperatures.
- **Characteristics:** Marked by torrential rain, scanty vegetation, and a sandy surface.

- **Soil Composition:** Dominated by salt and sand, with a deep groundwater table.
- **Lack of Surface Water**: Scarce surface water, creating a desert-like environment.
- **Sahara Desert:** The main area of the Sahara desert spans 9.4 million square kilometers, with a population of about 2.5 million, and lacks permanent settlements.

Exceptions

- **Gold Mines in Kalgoorlie and Coolgardie (Australia):** Despite the challenging environment, these regions in Australia host gold mines and human activity.
- **Oil Regions of Libya and Arabia (Petro Economy)**: Economic activities related to oil extraction drive settlements in the oil-rich regions of Libya and Arabia.
- **Central Asia (Low Density due to Climatic Continentality):** The climatic continentality of Central Asia contributes to low population density despite the overall high-temperature conditions.
- **Iron Ore Mines Region of Sweden:** Despite the challenging climate, the iron ore mines region in Sweden stands as an exception with human activity.
- **Coal, Oil, and Salt Areas of Siberia and Asiatic Tundra:** Certain resource-rich areas, such as those with coal, oil, and salt in Siberia and Asiatic tundra, see human activity despite the inhospitable environment.

Dense Forests Region

- **Taiga Forest Areas (55 to 66 degrees North):** Encompasses the expansive taiga forest belt within the latitudes of 55 to 66 degrees North.
- **Very Dense Forests in Northern Canada and Siberia:** Northern Canada and Siberia are characterised by extremely dense forests, often referred to as the land of mosquitoes.
- **Moist Surface throughout the Year:** The regions maintain a moist surface throughout the year, contributing to their dense forest cover.
- **Podzol Soil with High Acidity**: Podzol soil dominates these areas, characterised by high acidity. Increased acidity results in more angular grain, making agriculture difficult or impossible.
- **Harsh Winter and Short Summer**: The winter season is severe, and summers are of very short duration in these regions.
- **Low Population Density:** The combination of factors, including harsh climate, acidic soil, and short growing seasons, leads to very low population density in northern Canada and Siberia.

High Altitude Regions

Encompasses all-mountain regions with altitudes exceeding 4000 meters, characterized by the absence of human activity.

- **Challenging Conditions**: Features very cold temperatures, steep slopes, lack of soil layer, and minimal vegetation, discouraging human settlement.

Examples

- **Tibetan Plateau:** A prominent example of a high-altitude region with challenging environmental conditions.
- **High Mountain Regions with Low Population Density:** Various high mountain regions exhibit an average population density of 3 to 5 persons per square kilometer, reflecting the inhospitable nature of these areas.

Sporadic Ecumene

These areas exhibit irregular and sporadic settlements, with large expanses remaining uninhabited while small points experience population clustering.

Examples

- **Larger Oases of Africa and West Asia:** Notable examples of irregular settlement patterns.
- **Islands of Java and Philippines:** These islands showcase sporadic settlement, with certain points densely populated.
- **Mesopotamia:** Irregular and sporadic settlement in this historical region.
- **Turanian Plains:** Areas with irregular settlement patterns.
- **Sporadic Ecumene with Mineral Resources:**
  - **Kiruna (Iron Ore - Sweden):** A significant settlement linked to iron ore resources.
  - **Namib Desert (Uranium - Namibia):** Settlement influenced by uranium mining.

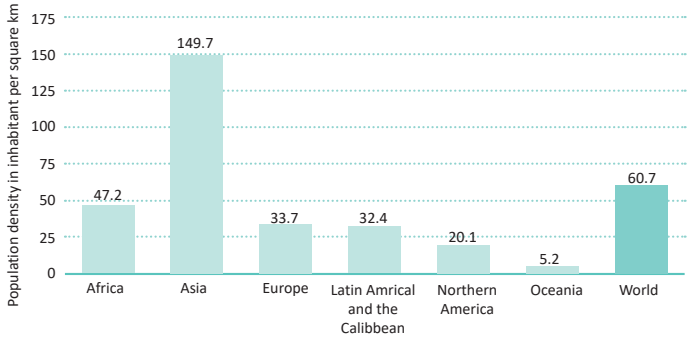


Fig. 5.16: Population Density Worldwide in 2021 by Region

World Population Prospects 2022: Observations on Future Population Trends

The world's population continues to grow, but several key observations suggest a **slowing and potential stabilisation** in the future

- Since 1951, the Population Division of the UN has been **releasing** the World Population Prospects (WPP) **every two years**.
- Each update of the WPP offers a **chronological sequence of population** metrics dating back to 1950.
- This is achieved by incorporating recently published national data to adjust estimations of previous **patterns in fertility, mortality, or international migration**

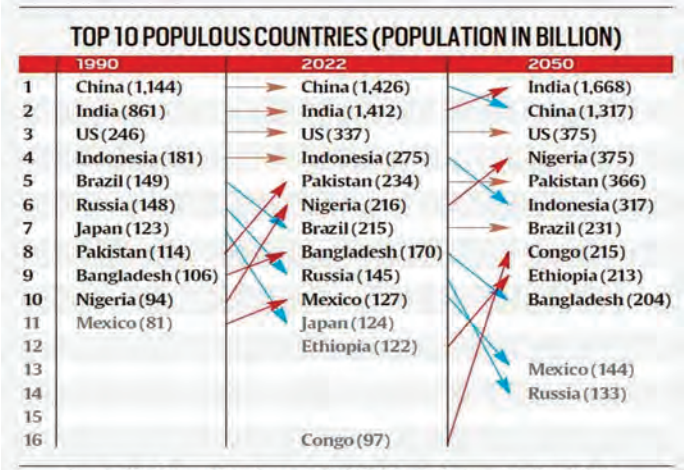


Fig. 5.17: Top Populous Countries in the World

What are the key Findings of the Report?

- The global population is estimated to hit 8 billion by November 15, 2022.
- According to the UN's latest projections:
  - **The global population may reach approximately:**
    - 8.6 billion by 2030,
    - 9.8 billion by 2050, and
    - 11.2 billion by 2100.
- **Factors contributing to population growth** include declining mortality rates and increased life expectancy.
- **Global life expectancy** was 72.8 years in 2019, and it could rise to around 77.2 years by 2050 with further reductions in mortality rates.
- **Women generally have a higher life expectancy than men**, with global averages of 73.8 years for women and 68.4 years for men.
- Population growth persists as long as fertility rates remain high and **mortality rates continue to decline**.
- The average fertility rate per woman was 2.3 births in 2021, down from 5 births in 1950, and it is projected to be 2.1 births by 2050.
- The **global growth rate fell below 1% in 2020** for the first time since 1950. Population is expected to reach 10.4 billion by the 2080s and continue until 2100.
- **Two-thirds of the projected population growth by 2050** is attributed to past growth momentum, even if fertility rates decrease to 2 births per woman.
- **Government actions** or initiatives have not been effective in reducing fertility rates or slowing down population growth.
- Increased fertility rates and population growth present challenges to achieving sustainable development goals, requiring more resources for education and health.

Population growth rates vary across countries and regions

- In 2022, the most populous regions are found in Asia, specifically Eastern and Southeastern Asia with a population of 2.3 billion, and Southern and Central Asia with 2.1 billion. China and India are the most populated countries in these regions, each with a population of 1.4 billion.
- The **majority of the projected population increase until 2050** is expected to occur in eight countries: The Democratic Republic of the Congo, Egypt, Ethiopia, India, Nigeria, Pakistan, the Philippines, and the United Republic of Tanzania.
- More than half of the population growth until 2050 is anticipated to be contributed by Sub-Saharan African countries.
- The 46 **least developed countries** (LDCs) are experiencing the fastest population growth and are expected to double their population between 2022 and 2050.
- Australia and New Zealand, Northern Africa and Western Asia, and Oceania (excluding Australia and New Zealand) are projected to experience slow yet positive growth rates. Meanwhile, Eastern and Southeastern Asia, Central and Southern Asia, Latin America and the Caribbean, and Europe and Northern America are expected to reach their peak size and **start declining before 2100.**
- Rapid population growth in many regions, such as Small Island Developing States (SIDS), will coincide with challenges like sea-level rise and climate change.

Increasing Population of Senior Citizens

- The proportion of individuals aged 65 years or older globally is **expected to increase from 10 percent in 2022 to 16 percent by 2050**.
- By 2050, the worldwide population aged 65 years or older is anticipated to surpass **twice the number of children** under the age of 5.
- A decline in fertility rates will lead to a shift towards an older population demographic.
- Women generally have a higher life expectancy compared to men across various populations. Globally, women make up 55.7% of the population aged 65 and above, but this percentage is projected to decrease to 54.5% by 2050.
- Countries with a growing elderly population must **prioritise sustainability and social security** by establishing efficient healthcare and pension systems.

WORLD - MAJOR RACES & TRIBES

The study of Races and Tribes within Geography is vital for comprehending the diverse human societies across the globe.

Human Evolution

- The journey of human evolution began during the Tertiary period, with initial ancestors emerging in Africa around 65 million years ago.

- Notable phases include **Ramapithecus, Australopithecus, Homo Habilis, Homo Erectus, Neanderthal Man,** and the global dispersion of **Homo sapiens** after the last glacial period.

Races of the World

- **Definition of Race:** A term referring to large groups sharing common inherited physical characteristics like skin color, hair type, facial features, and head shape.
- **Influencing Factors:** Climate, climatic changes, and hormonal influences contribute to racial differences.
- **Physical Characteristics of Races:** Examining characteristics of Caucasoid, Negroid, and Mongoloid races, including skin color, head hair, body hair, eye color, special eye features, head form, face, and nose.
- **Hormonal Influence:** Explanation of how pituitary, thyroid, and adrenal glands influence racial differences.
- **Biological Mutation and Selection:** Overview of Hugo De Vries' Mutation Theory of Evolution.

Classifications of Human Races

- **Linnaeus' Effort:** The first scientific attempt to classify human races in the 18th century.
- **Three Broad Races:** Caucasoid, Mongoloid, and Negroid based on origin and variations.

Major Races of the World			
Characteristic	**Caucasoid**	**Negroid**	**Mongoloid**
Skin Colour	Light to olive brown. Some are brown.	Brown to black. Yellow-brown.	Light yellow to reddish brown. Some are brown-black.
Hair	Blonde to dark brown. Coarse and curly.	Black. Woolly and wavy.	Black. Straight to wavy. Varies in texture.
Body Hair	Moderate to profuse	Slight	Sparse
Eye Colour	Light brown to brown-black	Dark brown	Brown to blue
Eye Fold	Lateral	Vertical	Epicanthic
Head Shape	Varies from narrow to broad. Pronounced jaw.	Narrow to medium. Broad and sometimes high.	Medium to broad. High cheekbones. Broad face.
Nose Shape	Varies from high bridge to low. Different types.	Low bridge. Different types.	Low to medium bridge. Different types.

MAJOR TRIBES OF THE WORLD

About **90%** of the global population lives in the **Northern Hemisphere**, with **Asia** alone accounting for **60%**, temperate regions like **Europe** for **30%**, and only **1%** residing beyond **60°N** in **Polar regions**. Recognizing the importance of indigenous cultures, **UNESCO** designated **1993** as the **International Year of the World's Indigenous People**, and on **August 9th of each** year, the **International Day of the World's Indigenous People** is observed. **India** is home to one of the largest tribal populations on a global scale.

MAJOR TRIBES OF THE WORLD		
Region	**Tribes**	**Unique Characteristics**
Africa		
Central & Southern Africa	Bantus	Negroid people speaking Bantu language
Kalahari Desert	Bushmen	Hunting-gathering aborigines, excellent stalkers and hunters
North West Africa	Hamites	Dark-skinned Muslims in North-West Africa
South Africa	Zulu, Xhosa, or Sotho and Khoisan	Martial people; Largest South African ethnic group
East Africa	Masai, Swahili	Nomadic cattle-rearing tribes and Pastoralists; Coastal people with Swahili language
West Africa	Fulani, Hausa	Nomadic herders; Large ethnic group in West Africa

Morocco	Berbers	Indigenous people of Morocco, Algeria, and Tunisia
Waziristan (Pakistan)	Masuds	Tribal group in Waziristan region of Pakistan, known for their martial skills
Asia		
Siberia (Russia)	Eskimos, Kirghiz, Tartar, Yakuts	Eskimos in tundra; Nomadic cattlemen with Kumis; People of Asiatic Tundra
Central Asia	Gaucho, Kazakhs, Kirghiz	Nomads of Pampas in Uruguay and Argentina; Nomadic cattlemen
Japan	Ainus	Original natives of Japan, distinct physical features
South-East Asia	Ibanas, Semangs	Equatorial rainforest tribes; Negrito ethnic groups
Middle East	Bedouins, Moors, Bedouin (Sahara and Middle East)	Semi-nomadic tribes in deserts; Dark-skinned Muslims in North-West Africa
Afghanistan (Waziristan)	Mehsuds	Tribal group in Waziristan region of Pakistan, known for their martial skills
EUROPE		
Hungary	Magyars	Ethnic group in Hungary, speak Hungarian language
Finland	Lapps	People of European tundra; Nomadic reindeer herders
South America		
Amazon Basin	Guicas, Baro, Maya, Punan	Indigenous tribes of the Amazon; Agrarian tribe in Central America; Farming and gathering tribe in Borneo
Argentina, Uruguay	Gaucho	Nomads of Pampas in Uruguay and Argentina
North America		
Alaska	Aleuts, Eskimos, Yupik	Inhabitants of Arctic region; Eskimos known for raw meat diet
Oklahoma (USA)	Apache	Plains tribe in the USA; Migrated from Siberia
North America (Various)	Native Americans	Aboriginals of North America; Mongoloid racial stock
Oceania		
Australia	Aboriginal Australians Bindibu	Indigenous people of Australia; Negroid people of Western Australia
New Zealand	Maoris	Original inhabitants of New Zealand; Engage in hunting and farming
Miscellaneous		
Philippines	Aeta, Etaz	Negrito ethnic group; Tribes in Philippines
Papua New Guinea	Papuan, Tapiro	Resemble Pygmies; Practice farming in Pacific Ocean
Tanzania	Hadza	Reside in Tanzania with a limited population of 200 people
Andaman Islands	Onge, Jarawa, Sentinalese	Endangered tribes; Reside in Andaman and Nicobar Islands

Fig. 5.18: Major Tribes of the World

IGNITE YOUR MIND

Tribal Tales: From Amazonian rainforests to African savannas, tribes face unique challenges in a globalized world. How can we protect their traditions and ensure their equitable development?

Some Noteworthy Facts

- **Esperanto** is an artificial language designed to serve as a world language.
- Tribes such as **Bedouin**, **Bakarwol**, and **Khirghiz** practice **nomadic herding** for subsistence.
- The **Inuit** people are found in the **Arctic regions** of **Canada**, **Denmark**, **Russia**, and **Alaska**.
- **Nomadic herding** is most common in dry areas.
- The **Caucasoid** racial group has the largest number of members.
- **Africa** is known as the 'Cradle of Mankind.'
- The original homes of the **Gypsies** were in **India**.
- The **Semang** tribe resides in dense tropical forests in **Malaysia**.
- **Zulu** is a ethnic group associated with **South Africa**.
- In **Latin America**, a person of **European** and **Indian** mixed blood is called **Mestizo**.
- **Pygmies** are primarily tribes engaged in hunting and gathering.
- The **Mongoloid** racial group is mainly found in **North America**.
- **Baiga** refers to tribes in **India**.
- **Transhumance** refers to the seasonal movement of people and their herds from the valley to the mountain and vice versa.
- The original home of the **Gypsies** was **India**.
- **Tuareg** pastoralists are from the **Sahara Desert**.
- Apart from **India**, **Tamil** is a major language in **Singapore**.
- The most recent within the **Homo sapiens** species is **Cro-Magnon Humans**.
- The Native African tribe **Pygmies** are found in the **Congo River** basin.
- **Eskimos** are inhabitants of **Canada**.
- **Armenia** was part of the erstwhile Soviet Union over which the **Kurdish** population is spread.
- **Scandinavia** is famous for the **Lapps** tribe.

DEMOGRAPHY OF INDIA

The demography of India is a multifaceted subject that encompasses the study of population dynamics, structure, distribution, and trends within the world's most populous country with a population of 142.86 crore as of April 2023.

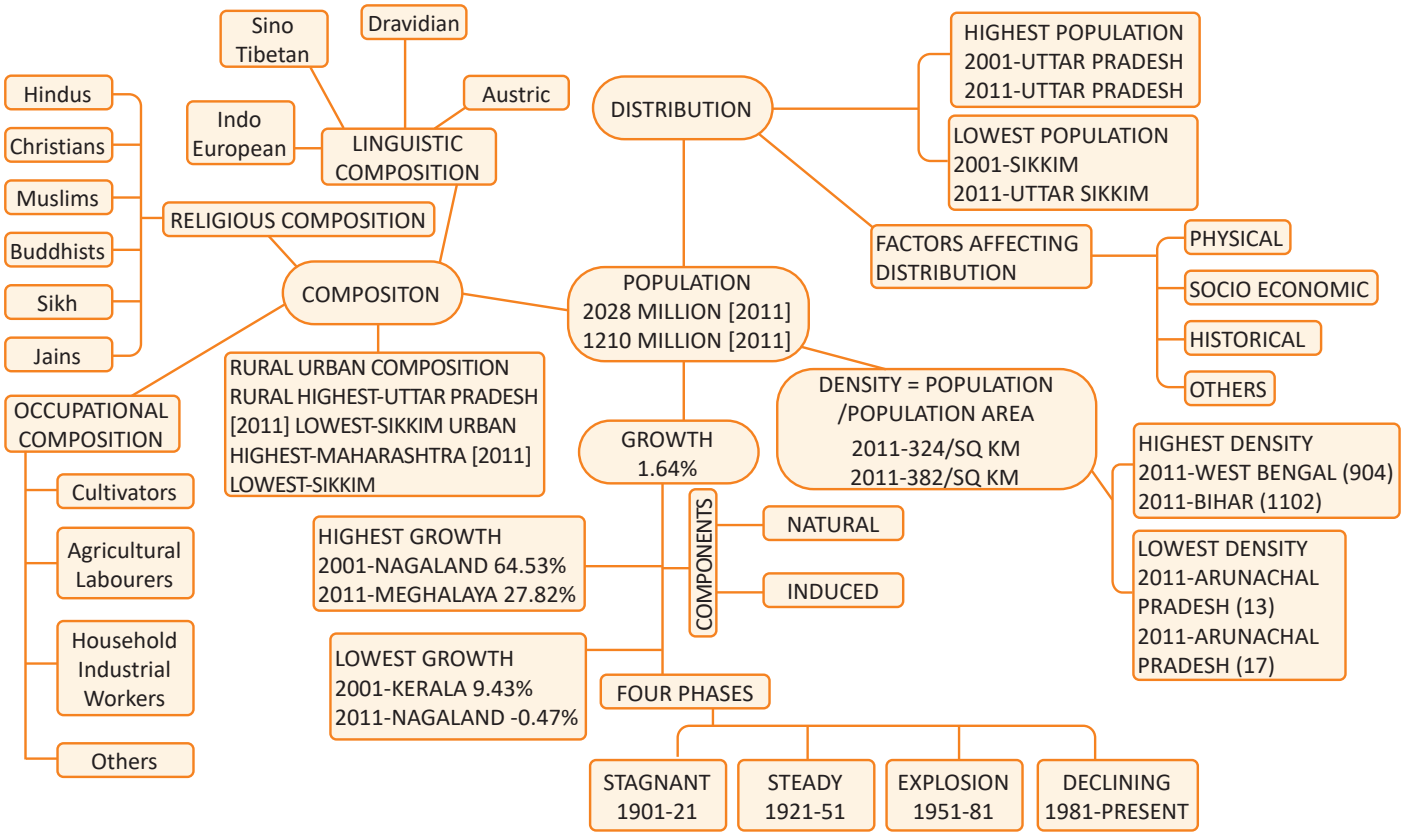


Fig. 5.19(a): Demography of India

Do You Know?

- **Crude birth rate (CBR)** is the number of live births per 1,000 people in a population in a year. It is a measure of the fertility of a population. Crude Birth Rate (CBR) is 19.5 as per Sample Registration System (SRS) Statistical Report 2020.
- **Crude death rate (CDR)** is the number of deaths per 1,000 people in a population in a year. It is a measure of the overall mortality of a population. Crude Death Rate (CDR) is 6 as per Sample Registration System (SRS) Statistical Report 2020.
- **Maternal mortality rate (MMR)** is the number of deaths of women from pregnancy-related causes per 100,000 live births. It is a measure of the health of women during pregnancy and childbirth. By 2018-20, India's MMR came down to 97.
- **Infant mortality rate** (IMR) is the number of deaths of infants under the age of 1 per 1,000 live births. It is a measure of the health of infants. The IMR in India according to NFHS-5 is 35.2 deaths per 1,000 live births.
- **Neonatal mortality rate** (NDR) is the number of deaths of infants under the age of 28 days per 1,000 live births. It is a measure of the health of newborns. The NDR in India according to NFHS-5 is 24.9 deaths per 1,000 live births.
- **Death rate** (DR) is the number of deaths per 1,000 people in a population in a year. It is a measure of the overall mortality of a population.
- **The fertility rate** is the number of children that a woman is expected to have over her lifetime. It is calculated by dividing the total number of births in a population by the number of women in that population.
- **Total Fertility Rate:** The total fertility rate (TFR) in India according to NFHS-5 is 2.0 children per woman.

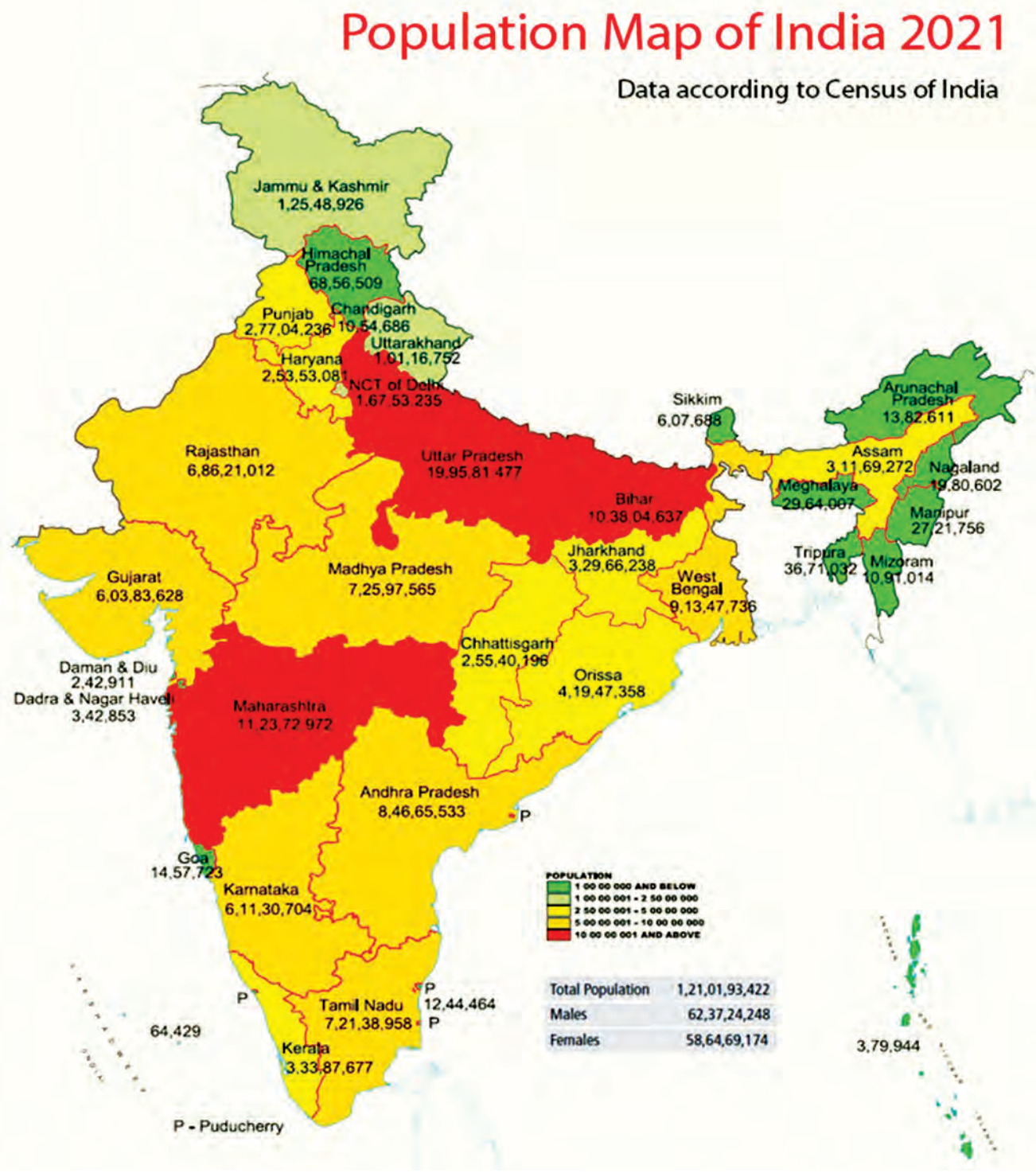


Fig. 5.19(b): Population Map of India (2011 Census)

Population Distribution In India

The **unequal distribution** of India's population is one of the most important elements of the country.

- On the one hand, India's population is **heavily concentrated in some places,** such as highly urbanised, industrialised, and agriculturally productive districts.
- On the other side, there are demographic deserts in the country's high mountains, dry terrain, densely wooded parts, and certain distant places.
- **Ten states in India**, namely Uttar Pradesh, Maharashtra, Bihar, West Bengal, Andhra Pradesh, Tamil Nadu, Madhya Pradesh, Rajasthan, Karnataka, and Gujarat, account for about **76% of the country's total population.**

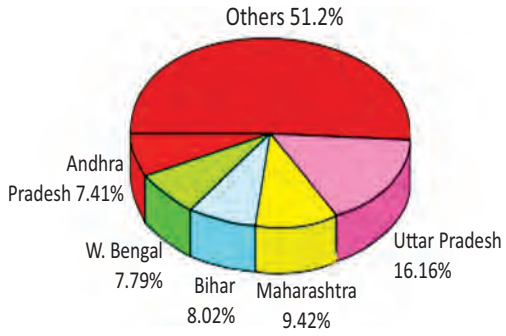


Fig. 5.20: State-wise Population Distribution in India

Population Density of India

The population density is stated as the **number of people per unit area**. It aids in gaining a better knowledge of population spatial distribution concerning land.

- In India (2011 Census), the population density is **382 people per square kilometre.** Over the previous 50 years, the population density has steadily grown from 117 people per square kilometre in 1951 to 382 people per square kilometre in 2011.

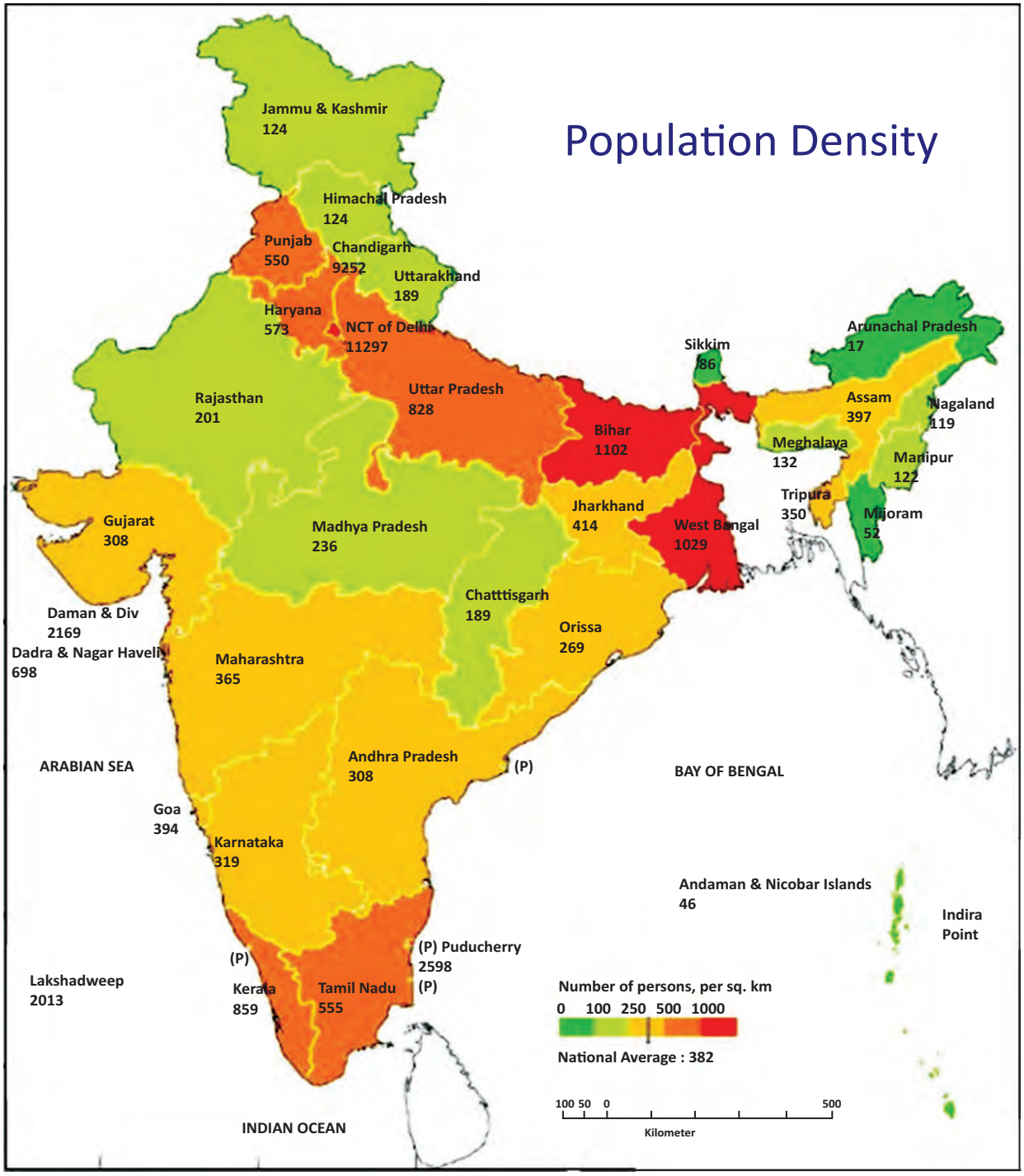


Fig. 5.21(a): State-wise Population Density in India

Temporal Distribution of Population Density in India

The temporal pattern of density of India shows that the country's population density has been **increasing steadily over time**. In 1951, the population density of India was 117 persons per square kilometre. By 2001, it had increased to 324 persons per square kilometre.

Year	Population Density (Persons per square kilometer)
1961	117
1971	143
1981	179
1991	230
2001	313
2011	382

Fig. 5.21(b): Population Density Trends in India

By 2011, it had increased further to **382 persons per square kilometre.** This means that the population density of India has more than tripled in the last 70 years.

- **According to the UN,** India's population is expected to grow for the next three decades, reaching 166.8 crore by 2050. After that, the population is expected to decline. The UN's "medium variant" projection estimates that India's population will peak at 1.7 billion people in 2064.
- The **population density of India** in 2022 was 431.11 people per square kilometer, a 0.68% increase from 2021. The population density of India in 2021 was 428.19 people per square kilometer, a 0.8% increase from 2020.

Spatial Pattern of Density Distribution In India

Based on state-level data, India's population density can be **divided into three broad zones**: high-density, moderate-density, and low-density areas.

1. **Areas of extremely low density:** Density below 100 People per square kilometre.
   - Arunachal Pradesh (17), Mizoram, Andaman & Nicobar, and Sikkim (86) have densities below 100 people per square kilometre.
   - Arunachal Pradesh, Mizoram, and Sikkim have **low density due to natural factors** like poor accessibility, harsh climate, and topography, while Andaman & Nicobar have tropical hot & humid climate, disease, dense forests, and tribal people, and lack of economic development. Developing agriculture is not feasible in arid or cold places.
   - **Uneven geography and limited agricultural** resources impede urbanisation and industrialisation. The number of people supported per unit area is low in certain places. Transport and communication challenges in hilly and mountainous locations impact economic growth at all levels.
2. **Moderate Density Areas**: States and Union Territories with a population **density of 100-400 people per square km** are considered moderately dense. This region is the largest in the country in terms of area.
   - Moderate population density is typically found in places with challenging topography, poor precipitation, and limited irrigation water. Providing infrastructure in this region can greatly expand the potential for **expanding primary and secondary activities**.
   - The Chotanagpur region was lightly inhabited before independence, but growth in mining and industry has led to a modest population density in this area.
3. **High-Density Areas:** Areas with a **population density of above 400 people per square kilometre** are classified as high density.
   - **Fertile land and heavy precipitation** in places like Kerala, West Bengal, and Tamil Nadu lead to high density because of fertile soil leading to food production for a large population. The situation differs significantly in Union Territories such as Delhi, Chandigarh, and Pondicherry.
   - These **urbanised regions provide** career prospects in industrial and service industries. Thus, dense populations are found in places with excellent land and abundant work prospects.

The Causes Of India's Regional Population Distribution

- **Fertility rates in India vary greatly**: Northern states have the greatest fertility rates, whereas southern states have the lowest. This is related to social and cultural standards, education, healthcare, and economic progress.
- **Drop In Mortality rates**: Mortality rates have dropped dramatically across India in recent decades, yet regional differences remain. The northern states have the greatest death rates, whereas the southern states have the lowest. Access to healthcare, sanitation, and nutrition contribute to this.
- **Migration**: The northern states send out migration, while the southern states take in migration. This is due to economic possibilities, education, and quality of life.

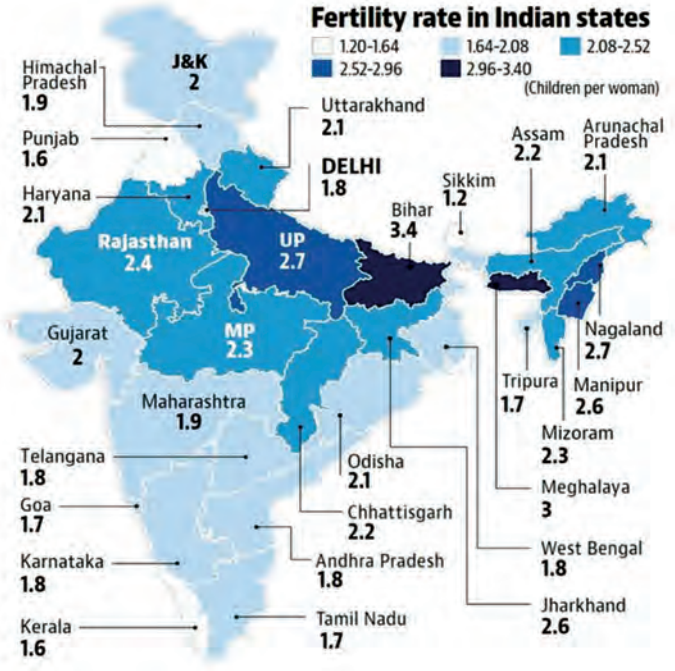


Fig. 5.22: State-wise Fertility Rates in India

The overall state-level pattern that emerges reflects a distinct north-south division. All of the **northern and northeastern states have had rapid growth**, whilst all of the southern states have experienced slow growth. This is mostly due to **disparities in socioeconomic development** between northern and southern states, such as greater literacy rates, better primary healthcare facilities, a larger urban population, a more developed economy, and so on. **Indian population growth varies regionally**, affecting economic and social policies.

Population Growth In India

The change in the number of people living in a certain location between two points in time is referred to as population growth**. It is made up of two parts: natural and induced.**

1. **The Natural Growth Rate**: The natural growth rate is defined as the difference **between the crude birth and death rates at two periods in time.**
2. **The Induced Growth Rate**: The volume of inward and outward mobility of individuals in any particular location explains it. In other words, the amount of net migration in a given area influences the pace of induced population increase.

Phases of Population Growth in India

Due to its fertile alluvial soils and suitable climate, **India houses 17.5% of the world's people on only 2.4% of the world's land area.** India's population growth rates, both decadal and yearly, are exceptionally high. The **decadal and yearly growth rates** of India's population are 17.64% and 1.64%, respectively (2011). India's population growth can be broken down into four phases.

Phase 1: The Stagnant Population Growth (1901-1921)

- **Relatively slow growth** (5%), the first stage of Demographic Transition, high birth and death rates, poor food supply, natural dangers, epidemics and famines, etc. were intermittent events.
- The **1921 census** was a watershed year (the **population growth rate was negative**). As a result, it is sometimes referred to as the **demographic divide**. Population decline in the northern and eastern zones.

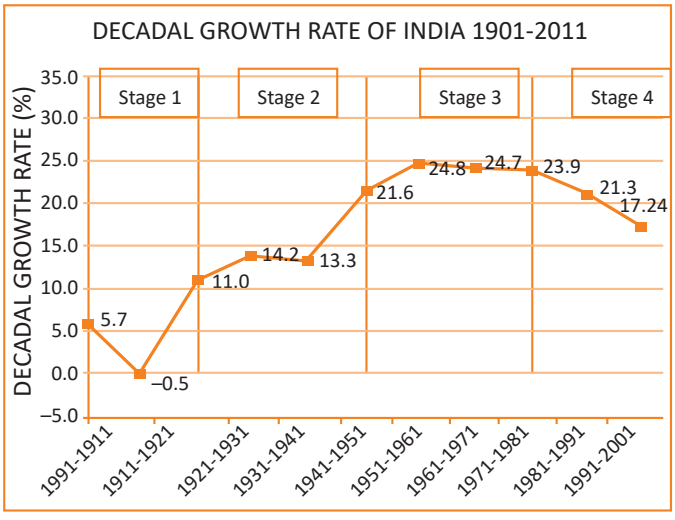


Fig. 5.23: Demographic Transition of India

- However, **immigration caused a net gain in population** in West Bengal and North-East India. The impact of negative growth was not noticed in the southern zone. **Kerala recorded 22%** growth over this period.

Phase 2: Steady Growth (1921-1951)

- Population rose from 250 million to 361 million during this phase. There was a **47% rise in population.**
- This was because of nationalistic pressure, the British government was forced to engage in developmental efforts such as **health improvement.** As a result, mortality rates have fallen dramatically.

Phase 3: High-growth period (1951-1981)

- Some instances of a reduction in birth rate (36) and mortality rate (12) were noticed in this phase. **Death rates dropped dramatically** after independence and the start of planned development.
- Because the **birth rate is more dependent on social growth**, which occurs only after a gap, there has been a slight fall in the birth rate to 36. Such a disparity in the mortality and birth rates resulted in a three-decade period of population growth in India.
- The total population expanded from 361 million in 1957 to 683 million in 1981. It is an example of **fertility-led population expansion.**

Phase 4: Period of High Growth Rate with Slowing Down (Post-1981)

- The decades from 1981 to the present have seen a **steady increase in population**, but the rate of growth has **begun to reduce gradually.** A decline in the crude birth rate is blamed for such population growth.
- The **average age at marriage increased**, and the family planning programmes expanded at a rapid rate. During this time, the country's quality of living improved, and female education was encouraged.

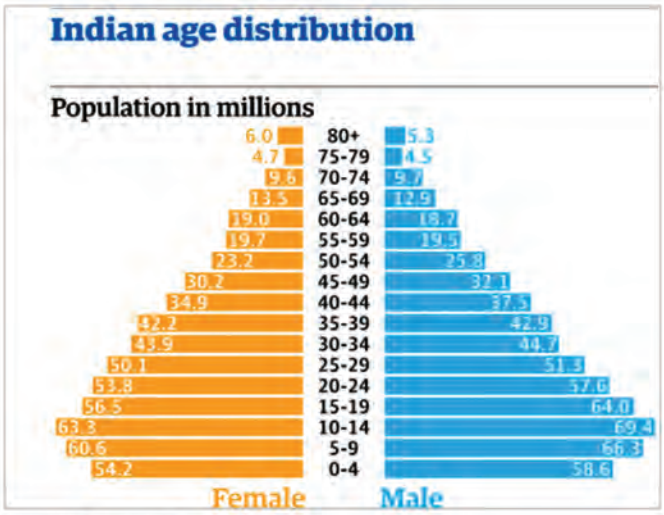
India is currently in Stage 3 of the **demographic transition theory**. Birth rates have been declining in recent decades, but death rates have also been declining. This has led to a slowdown in population growth. However, **India's population is still projected to grow** significantly in the coming decades.

Age Composition of India

The age composition of a country is an **essential measure of its growth**. Younger people are frequently more economically vibrant than older groups. This is because young individuals are more inclined to enter the labour market and establish firms. Countries with youthful populations, on the other hand, have **additional obstacles**, such as the need to invest in education and healthcare.

- In 2011, India had a favourable age structure, with **60% of the population being adults and 40% being young and elderly**. Even within this, 34.4% were children and 6.9% were seniors.

- Although the number of children was **higher than the global norm**, the proportion of old individuals was close to the global average of 9%. The 2011 census data shows an inverted age-sex pyramid in India.



Source: Economic Census 2011

Fig. 5.24: Age Composition of India

- The birth rate is dropping because the **proportion of people under 10** is lower than 10-14. The **population is shrinking as age increases**. People over 80 are rising again. The proportion of females is lower in all age categories except the 55-59 age group, where it increases somewhat.

Feature of Age Composition of India

- The country is transitioning from a **demographic transition**, where birth rates are dropping, which is a good indicator.
- As **birth and mortality rates decrease**, the proportion of old people is rising over time. Over 50 years, there has been a 2.9-point gain. This growth indicates a trend of **strengthening medical facilities** in the country.

State-wise Age Composition

- The distribution of age composition per state indicates the demographic transition stage. Kerala is in the last stages of demographic transition and has an age mix similar to many modern countries.
- Kerala has a children population of 23.44 per cent, significantly lower than the global average of 26 per cent. Its 12.55 per cent elderly population is the highest in the country and exceeds the world average of 9%.

Changing Age Compositions In States

- As populations shift the youthful age structures move to old age structures, resulting in population ageing.
- In Kerala, Goa, Tamil Nadu, Punjab, and Himachal Pradesh, the proportion of children ranges from 21 to 26%, whereas the senior population ranges from 10 to 13%.
- The lowest percentage of children in the population is 21.81 per cent in Goa. On the other hand, states like Bihar, Meghalaya, Jharkhand, Uttar Pradesh, and Arunachal Pradesh have 35-40% kid populations.
- This shows the first or second stage of demographic transition, where mortality rates have decreased but birth rates have not. This results in a larger kid ratio in their population.

India Ageing Report 2023

- **Demographic Trends:** India's elderly population is experiencing rapid growth, with a decadal increase of 41%. By 2050, more than 20% of India's population will be elderly.
- The elderly population is projected to surpass the population of children (0 to 15 years old) by 2046.
- The population of individuals aged 80 and above is anticipated to rise by approximately 279% between 2022 and 2050.
- **Higher Life Expectancy of Women:** Women exhibit a higher life expectancy at ages 60 and 80 compared to men, with variations observed across states and territories.In states like Himachal Pradesh and Kerala, women aged 60 have a life expectancy of 23 and 22 years, respectively, exceeding that of men by four years — a differential greater than the national average of 1.5 years.
- **Poverty and Well-being:** Over 40% of India's elderly population belongs to the poorest wealth quintile. Poverty among the elderly adversely affects their quality of life and healthcare utilisation, with a significant proportion, particularly women, living without any income.
- **Regional Variations:** Significant inter-state variations exist in the elderly population and their growth rates. States in the southern region and select northern states such as Himachal Pradesh and Punjab report a higher share of the elderly population than the national average, a gap expected to widen by 2036.
- **Sex Ratio of the Elderly Population:** The sex ratio among the elderly has been steadily increasing since 1991, while the ratio in the general population remains stagnant.
  - In the northeast and east, the sex ratio of the elderly remains below 1,000, indicating a male predominance even among those aged 60 and above.
  - However, in central India, the sex ratio rose from 973 in 2011 to 1,053 in 2021, indicating a significant increase in female survival rates after the age of 60 over the decade.
- **Low Awareness of Social Security Schemes:** There is a lack of awareness among the elderly regarding various social security schemes tailored for them.
  - Approximately 55% of the elderly are aware of the old-age pension scheme (IGNOAPS), while 44% are aware of In states like Himachal Pradesh and Kerala, women aged 60 have a life expectancy of 23 and 22 years, respectively, exceeding that of men by

four years — a differential greater than the national average of 1.5 years.

- **Poverty and Well-being:** Over 40% of India's elderly population belongs to the poorest wealth quintile. Poverty among the elderly adversely affects their quality of life and healthcare utilisation, with a significant proportion, particularly women, living without any income.
- **Regional Variations:** Significant inter-state variations exist in the elderly population and their growth rates. States in the southern region and select northern states such as Himachal Pradesh and Punjab report a higher share of the elderly population than the national average, a gap expected to widen by 2036.
- **Sex Ratio of the Elderly Population:** The sex ratio among the elderly has been steadily increasing since 1991, while the ratio in the general population remains stagnant.
  - In the northeast and east, the sex ratio of the elderly remains below 1,000, indicating a male predominance even among those aged 60 and above.
  - However, in central India, the sex ratio rose from 973 in 2011 to 1,053 in 2021, indicating a significant increase in female survival rates after the age of 60 over the decade.
- **Low Awareness of Social Security Schemes:** There is a lack of awareness among the elderly regarding various social security schemes tailored for them.
  - Approximately 55% of the elderly are aware of the old-age pension scheme (IGNOAPS), while 44% are aware of the widow pension scheme (IGNWPS), and only 12% are aware of the Annapurna Scheme.

Demographic Dividend

The demographic dividend is a concept related to the **demographic profile of a population**, particularly in the context of economics and development. It refers to the period in a country's demographic transition when the **working-age population,** typically between 15 and 64 years old, is larger than the dependent population i.e. children and the elderly.

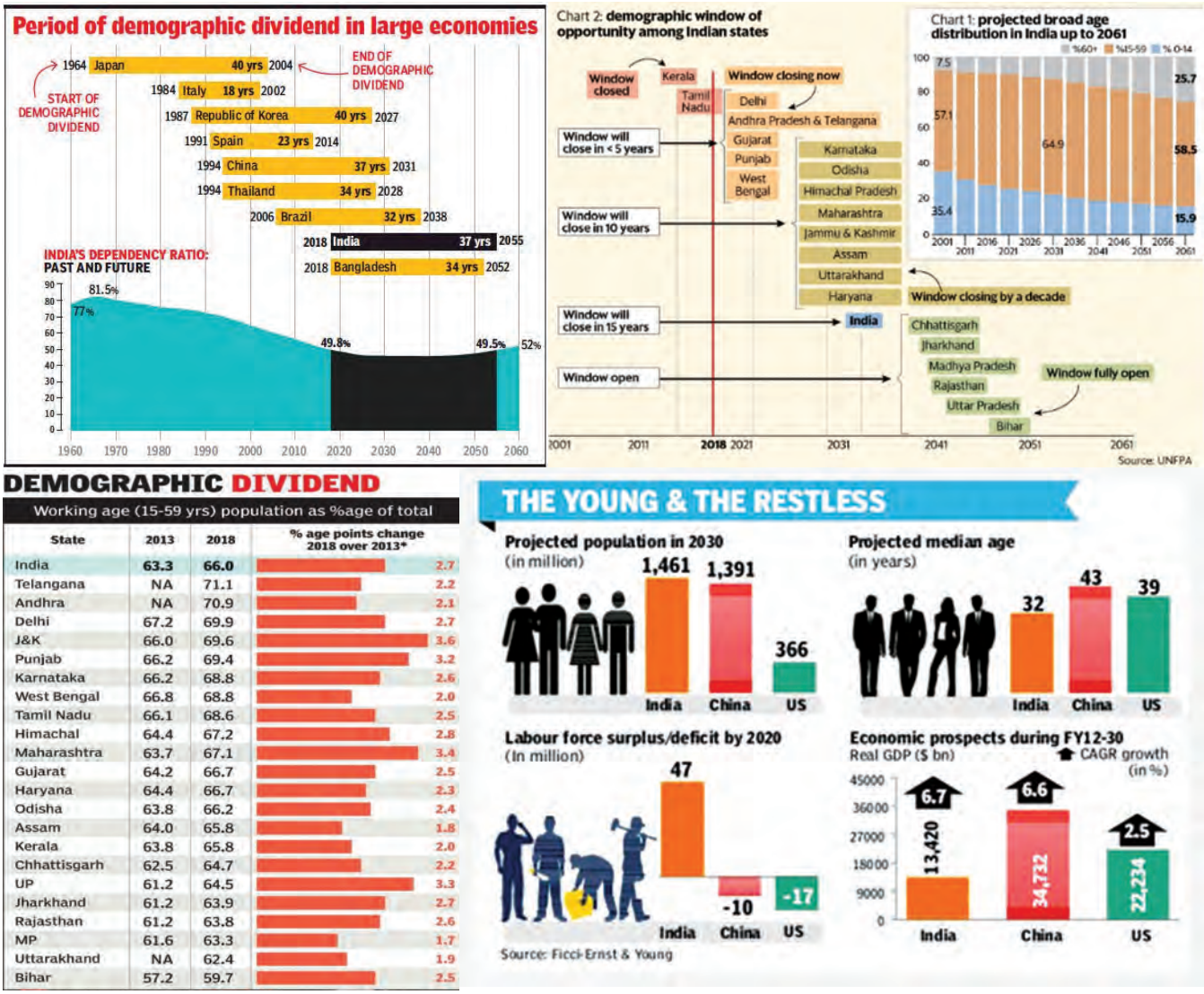


Fig. 5.25: Demographic Dividend in India

- India is currently amid its demographic dividend, which is expected to last until 2055. India has a **large and growing working-age population**, and its dependency ratio is declining.
- This is a golden opportunity for India to achieve rapid economic growth and raise living standards for its citizens.

However, there are **several challenges** that India needs to address to reap the full benefits of its demographic dividend. These challenges include:

- **Creating Enough Jobs:** India needs to create enough jobs for its growing working-age population. This will require investment in education and training, as well as in infrastructure and economic development.
  - If policymakers talk about providing jobs for 5 million-8 million young people in India, it will barely scrape the surface of the country's unemployment crisis.
- **Skilling The Workforce:** India needs to ensure that its **workforce has the skills** needed to meet the demands of the modern economy. This will require investment in education and training, as well as in on-the-job training.
  - The proportion of formally **skilled workers in India is extremely low**, at 4.69% of total workforce, compared to 24% in China, 52% in the US, 68% in the UK, 75% in Germany, 80% in Japan and 96% in South Korea.
- **Improving Female Labor Force Participation:** 29.4% of women (aged 15-59) were part of India's labour force in 2021-22.
  - India's **female labour force participation rate** is one of the lowest in the world. This needs to be improved to reap the full benefits of the demographic dividend.
- **Urbanisation:**
  - **Rapid urbanisation** accompanying the demographic dividend can strain infrastructure and resources in cities, leading to social and economic challenges.
  - **Rapid Pace:** By 2050, 68% of the world's population will live in cities (UN DESA).
  - By 2030, India's urban population will reach 600 million, and will put pressure on resources and infrastructure.
  - **Water:** 21 cities face "Day Zero" by 2020 (NITI Aayog).

IGNITE YOUR MIND

Megacity Mania: Megacities are bursting, while rural areas shrink. Tokyo, Mumbai, Lagos - megacities offer opportunity but grapple with congestion, inequality and environmental strain. Are these urban giants the inevitable future, or do we need a more decentralized approach? Can we create a more balanced, livable and sustainable urban-rural landscape for the future?

- **Environmental Sustainability:**
  - A larger population puts additional pressure on the environment, requiring sustainable practices to manage resource consumption and pollution.
  - **Resource Demands:** By 2050, global resource use is expected to increase by 80% (OECD).
  - **Sub-Saharan Africa's Concerns:** Water scarcity affects 250 million people in sub-Saharan Africa (World Bank).

Demographic Disaster

A demographic disaster refers to a significant and often negative shift or change in the demographic characteristics of a population or a region. This can encompass various factors, including changes in population size, age distribution, birth rates, death rates, migration patterns, and other demographic indicators. Such disasters can have far-reaching social, economic, and political implications, particularly if they are sudden or extreme.

Way Forward

While demographic dividend holds immense promise for **economic growth and development**, it is crucial to acknowledge the multifaceted challenges that must be addressed to fully harness its potential.

Investing in Human Capital

- **Education and skills development:** Equip individuals of all ages with relevant skills to adapt to changing job markets and contribute meaningfully to the economy. Encourage lifelong learning opportunities.
- **Healthcare and well-being:** Ensure access to quality healthcare across all age groups, promoting healthy ageing and active lives.
- **Social protection:** Strengthen social safety nets and pension systems to provide security and dignity for older adults.

Policy Adaptations

- **Labour market policies:** Consider flexible work arrangements, encourage later retirement ages, and address age discrimination in workplaces.
- **Demographic dividend strategies:** Countries with young populations can utilize them effectively through job creation, education, and infrastructure development.
- **Addressing ageing populations:** Adapt social security systems, promote intergenerational solidarity, and explore immigration policies to address labour shortages.

Technological Innovations

- **Assistive technologies:** Utilise technology to support independent living and healthcare for older adults.
- **Automation and AI:** Utilise automation for tasks unsuitable for humans while focusing on reskilling and upskilling workforces.
- **Smart cities and infrastructure:** Design infrastructure and services that cater to the needs of diverse age groups.

Dependency Ratio

The dependency ratio is a measure that **expresses the number of dependents** (typically children below a certain age, usually 15 or 20, and elderly individuals above a certain age, usually 65 or 64) as a percentage of the working-age population (usually between 15 and 64 years old).

- It is often **calculated separately** for youth dependency (the ratio of children to working-age population) and elderly dependency (the ratio of elderly to working-age population).
- A **higher dependency ratio** means that there are more dependents for each working-age person to support. This can put a strain on the economy and make it more difficult to achieve economic growth.
- The dependency ratio is a useful tool for policymakers and economists to **track the changing demographics** of a population and to assess the potential impact of these changes on the economy.
- **India:** The dependency ratio in India has been **declining in recent years**, but it is still relatively high. In 2021, the dependency ratio in India was 72%, which means that there were **72 dependents for every 100 working-age people.**
- This is a **significant improvement** from the dependency ratio of 139% in 2001, but it is **still higher than the global average** of 54%.

The Decline in the Dependency Ratio is Due to Several Factors, including

- **Declining Fertility Rates**: This is because of factors, including increased education and employment opportunities for women, and the availability of family planning services.
- **Increasing Life Expectancy**: This is due to several factors, including improved healthcare and nutrition, and a decline in infant mortality.
- **Increasing Labor Force Participation Rates**: This is due to several factors, including increased education and employment opportunities for women, and a decline in the social stigma associated with female employment.

The **decline in the dependency ratio** is a **positive development** for the Indian economy. This means that there is a **larger working-age population to support the dependent population**. This can lead to increased economic growth and higher living standards for all Indians.

Rashtriya Vayoshri Yojana

In April 2017, the Ministry of Social Justice and Empowerment introduced a scheme called "Rashtriya Vayoshri Yojana (RVY)" aimed at providing **physical aids and Assisted Living Devices** to Senior Citizens belonging to the **BPL** category.

- The objective was to provide Senior Citizens, belonging to the BPL category and suffering from age-related disabilities/ infirmities, with physical aids and assisted living devices that could restore near-normalcy in their bodily functions.
- Under the Scheme, assisted living devices such as Walking Sticks, Elbow Crutches, Walkers/ Crutches, Tripods/ Quadpods, Hearing Aids, Wheelchairs, Artificial Dentures, and Spectacles were provided free of cost to the beneficiary senior citizens.

Sex Composition

Sex composition is one of the most **fundamental demographic aspects** of the human population, and it is critical for any useful demographic study. **Changes in sex composition** reflect underlying socioeconomic and cultural characteristics of a society in a variety of ways.

- The sex ratio is an important social statistic that **measures the degree of equity** that exists between males and females in a community at any particular period.
- The sex ratio is a useful tool for **determining the number of women** in the country and the **gender ratio**. The term "sex ratio" refers to the **number of females per 1000 males**.

Determinants of Sex Ratio

There are wide regional variations in the sex ratio. This ratio is mainly determined by **three basic determinants**, which are sex ratio at birth, sex ratio at death and sex ratio of the migrants.

Sex Ratio of India

According to the 2011 Census of India, the country's sex ratio was 943 females for every 1000 males. It was ten points higher than the 2001 sex ratio. This was the highest level since 1971. The country's sex ratio has historically been negative, which has been detrimental to females.

- **Pattern of Sex Ratio:**
  - The sex ratio **fell steadily until 1941**, then recovered slightly in 1951. For the second time in two decades, the sex ratio fell and then somewhat recovered in 1981.
  - However, in 1991, the country had the lowest sex ratio in the century, with 927 females for every thousand males. However, between 1991 and into the new millennium, the sex ratio has improved, rising from 933 in 2001 to 943 in 2011.
  - This **increase is due to the various initiatives** taken by the Government of India to address the dwindling sex ratio. The most notable is the prohibition on prenatal sex determination.
  - As per the **5th report of National Family Health Survey** (NFHS-5, 2019-21) of Ministry of Health and Family Welfare the sex ratio of total population (females per 1000 males) is 1020 for the country as a whole, with sex ratio rural at 1037 and sex ratio urban at 985.

Fig. 5.26: Sex Ratio in India

KEY FINDINGS OF NFHS-5

❑ Declining Total Fertility Rate (TFR)

- The TFR in India has fallen below the replacement threshold, indicating a decrease in the average number of children born per woman.
- As of 2019-2021, the TFR stands at 2, slightly below the replacement rate of 2.1.
- While rural areas maintain a TFR of 2.1, urban areas saw a decline below replacement levels as early as the 2015-16 National Family Health Survey (NFHS).

❑ Ageing Population

- The decrease in TFR suggests a shift towards an older population demographic in India.
- The share of the under-15 population declined from 28.6% in 2015-16 to 26.5% in 2019-21, reflecting this trend.

❑ Child Nutrition

- Nationally, there has been a slight improvement in child nutrition indicators, with reductions observed in stunting, wasting, and underweight prevalence rates.
- However, the prevalence of overweight children has increased from 2.1% to 3.4%.

❑ Anaemia

- The incidence of anaemia has worsened across all demographic groups in India, with severe levels reported in all states except Kerala.
- Under-5 children, women, and men have experienced increased anaemia rates, raising concerns about public health.

❑ Immunisation

- Full immunisation coverage among children aged 12-23 months has substantially improved, rising from 62% to 76% nationally.
- Many states and union territories (UTs) have achieved high immunization rates, with Odisha leading at 90%.

❑ Institutional Births

- Institutional deliveries have seen a significant increase from 79% to 89% nationwide.
- Puducherry and Tamil Nadu have achieved 100% institutional delivery rates, with over 90% observed in seven other states/UTs.

❑ Family Planning

- The Contraceptive Prevalence Rate (CPR) has risen notably from 54% to 67% nationwide, accompanied by increased usage of modern contraceptive methods.

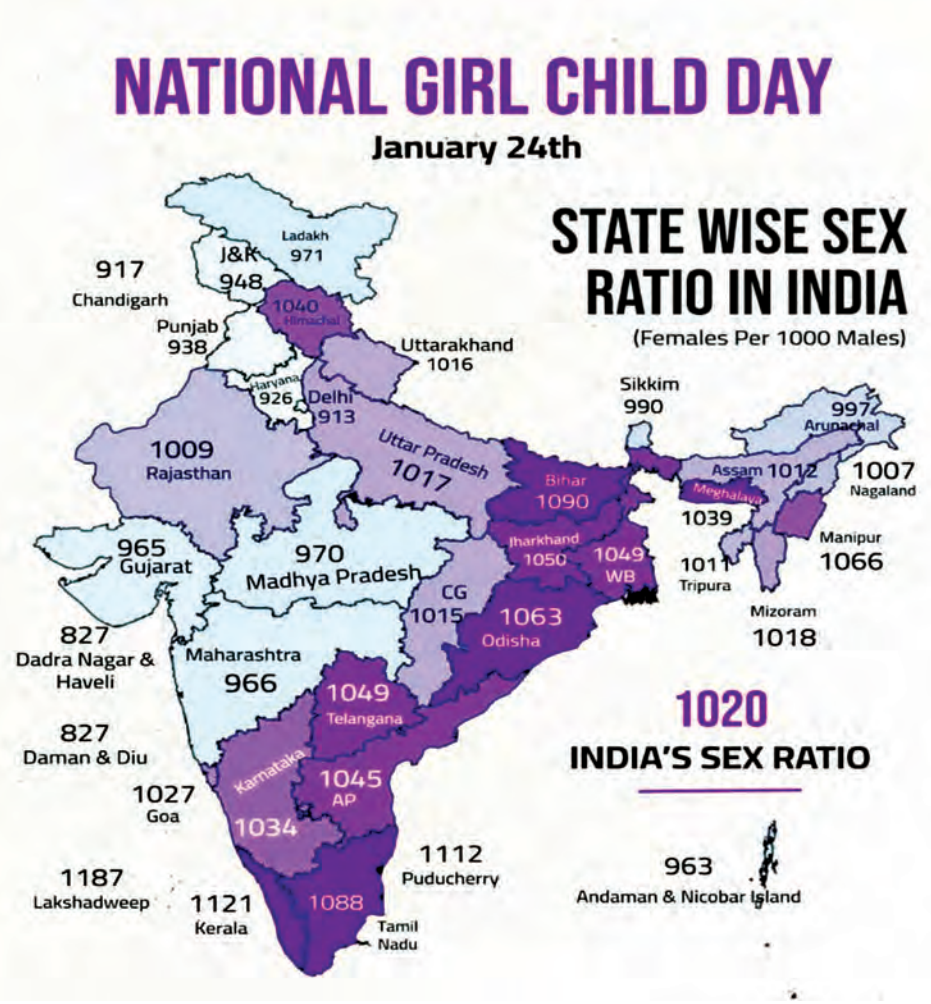


Fig. 5.27: State-wise Sex Ratio in India

- The unmet need for family planning has declined substantially, indicating improved access to and acceptance of contraceptive services.

❑ **Breastfeeding Practices**

- Exclusive breastfeeding for children under 6 months has shown improvement nationally, increasing from 55% to 64%.
- Progress in breastfeeding practices is observed across all states and UTs in the second phase of the NFHS.

❑ **Women Empowerment:**

- Women's empowerment indicators demonstrate significant advancement nationwide and across phase-II states/UTs.
- Notably, the proportion of women operating bank accounts has increased from 53% to 79% nationally, with over 70% observed in every state and UT during the second phase.

Key Terms

Total Fertility Rate (TFR)

❑ TFR represents the average number of children a woman is expected to have during her reproductive years, typically between 15 and 49.

❑ The replacement level indicates the minimum fertility rate needed to maintain a stable population, accounting for factors like mortality rates and sex ratios.

Contraceptive Prevalence Rate (CPR)

❑ CPR measures the percentage of women currently using contraception or whose partners are using it, irrespective of the method chosen.

❑ It is reported as a percentage within specific marital status and age groups.

Sex Ratio at Birth (SRB)

❑ SRB denotes the number of female births per 1,000 male births, serving as an indicator of societal preferences for male offspring over female.

Stunting

❑ Stunting refers to impaired growth and development in children, resulting from inadequate nutrition, frequent infections, and insufficient psychosocial stimulation.

❑ It is often a consequence of chronic undernutrition, associated with poverty and inadequate maternal health and care.

Wasting

❑ Wasting is characterised by low weight-for-height and typically signifies recent and severe weight loss in children.

❑ It can persist due to prolonged malnutrition and is associated with an increased risk of mortality if not addressed promptly.

Infant Mortality Rate (IMR)

❑ IMR quantifies the number of deaths among children under one year of age per 1,000 live births in a given year.

❑ India's average IMR stands at 32 per 1,000 live births, with rural areas experiencing higher rates compared to urban areas.

❑ **Sex Ratio in Urban Landscape:**

- The rural sex ratio was 949 girls for every 1,000 men, whereas the urban sex ratio was just 929.
- That is, the **rural sex ratio was higher than the urban sex ratio**, but the influence of male-selective rural-to-urban migration must be considered before reaching any broad conclusions.
- **Kerala had the highest sex ratio** (1084) and Daman & Diu had the lowest (618). Only two states, Kerala and Puducherry, had a sex ratio of more than 1,000 females for every thousand males.

❑ **Rural-Urban Divide in Sex Composition:**

- In Kerala, the urban-to-rural sex ratio was higher than the national average. Only a few states have a higher urban sex ratio than rural areas. These were Chandigarh, Meghalaya, Manipur, Mizoram, the NCT of Delhi, Puducherry, Sikkim, Tamil Nadu, and Tripura. Five states/union territories have more than 1,000 females per thousand males in rural areas. Chhattisgarh, Goa, Kerala, Puducherry, and Uttarakhand were among them.
- **District Profile of Sex Ratio:** The Mahe district of Puducherry Union Territory has the greatest sex ratio in the country, with 1184 females per thousand men, followed by Almora (1139) and Kannur (1136). Daman district has the lowest sex ratio, with 534 females for every thousand males. Around 99 districts had a female-to-male ratio of 1000 or above.

Child Sex Ratio (0-6 Age Group)

- While the general sex ratio in the country is displaying promising trends, the same is not true for girls aged 0-6 years. Census data from 2011 reveal a downward trend in the country's child sex ratio.
- The **child sex ratio has steadily decreased** from 976 girls per thousand boys to 918 females per thousand boys.
- **Changing Demographics:** Between 2019-21, India witnessed a significant demographic shift, with 1,020 adult women recorded per 1,000 men for the first time.
- Despite this recent development, India continues to grapple with a **skewed sex ratio at birth (SRB)**, favouring boys over girls.
- The **natural SRB stands** at 952 girls per 1,000 boys, indicating an ongoing gender disparity.
- **Regional Disparities:**
  - Several major states in India, including Uttar Pradesh, Haryana, Punjab, Rajasthan, Bihar, Delhi, Jharkhand, Andhra Pradesh, Tamil Nadu, Odisha, and Maharashtra, exhibit low SRB rates.
  - These states face significant challenges in addressing gender imbalances and promoting gender equality.
- Ironically, two of India's most agriculturally developed states (Punjab and Haryana), dubbed as the **"food bowl of India,"** had the lowest proportion of girls in their population.
- The child sex ratio was substantially higher in rural Chhattisgarh and the Andaman and Nicobar Islands. In contrast, even in rural areas of Haryana and Punjab, the child sex ratio was the poorest. However, the country's **metropolitan regions had a severe shortage of females**, with only 905 girls for every 1000 boys.

The Indian Government has taken Several Measures to Reverse the Sex Ratio In India, including

- **The Pre-Conception and Pre-Natal Diagnostic Techniques (Prohibition of Sex Selection) Act, 1994 (PCPNDT Act):** This act prohibits sex determination tests before or after conception and the selection of the sex of a fetus.
- **The Beti Bachao Beti Padhao (BBBP) Scheme**: This scheme was launched in 2015 to address the decline in the Child Sex Ratio (CSR) of girls (0-6 years) in 100 select districts of India. The scheme aims to improve CSR and ensure the education and empowerment of girls.
- **Pradhan Mantri Matru Vandana Yojana (PMMVY)**: This scheme was launched in 2016 to provide financial assistance to pregnant women and lactating mothers. The scheme aims to improve the nutritional status of mothers and children and reduce maternal and child mortality.
- **Sukanya Samriddhi Yojana (SSY)**: This scheme was launched in 2014 to encourage parents to save for the future of their daughters. The scheme offers a high-interest rate and tax benefits.

Linguistic Composition

India is rightly characterised as a polyglot nation, reflecting its diverse linguistic landscape. Studies indicate that in the past, limited transportation options restricted people's mobility, resulting in **isolated communities speaking** distinct dialects within small geographic areas, typically spanning 7-8 kilometres.

Consequently, India currently boasts a remarkable array of 1,572 languages and dialects, each with fewer than 100,000 speakers, in addition to the **22 Scheduled languages**.

Fig. 5.28: Linguistic Families of India

Four Major Linguistic Families in India are

1. **Indo-Aryan:** The largest language family in India, with over 70 crore speakers. It includes languages such as Hindi, Bengali, Punjabi, Marathi, Gujarati, and Assamese. Indo-Aryan languages are spoken in all parts of India, but they are most concentrated in the north and central regions.
2. **Dravidian:** The second largest language family in India, with over 25 crore speakers. It includes languages such as Tamil, Telugu, Kannada, and Malayalam. Dravidian languages are spoken in the southern and eastern parts of India.
   - According to the current count, there are 26 Dravidian languages, 25 of which are spoken in India and one (Brahui) spoken in Baluchistan on the Pakistan-Afghanistan border.
3. **Austroasiatic**: A smaller language family, with about 10 crore speakers in India. It includes languages such as Santali, Munda, and Khasi. Austroasiatic languages are spoken in the eastern and northeastern parts of India.
4. **Tibeto-Burman**: The smallest of the four major language families in India, with about 5 crore speakers. It includes languages such as Nepali, Manipuri, and Bodo. Tibeto-Burman languages are spoken in the northeastern and Himalayan regions of India.

Distribution of Population by Language

India is a country rich in linguistic diversity. **According to Grierson** (Based on Linguistic Survey of India, 1903 - 1928), the nation has 179 languages and up to 544 dialects. There are around **22 scheduled languages and several non-scheduled languages** in modern India.

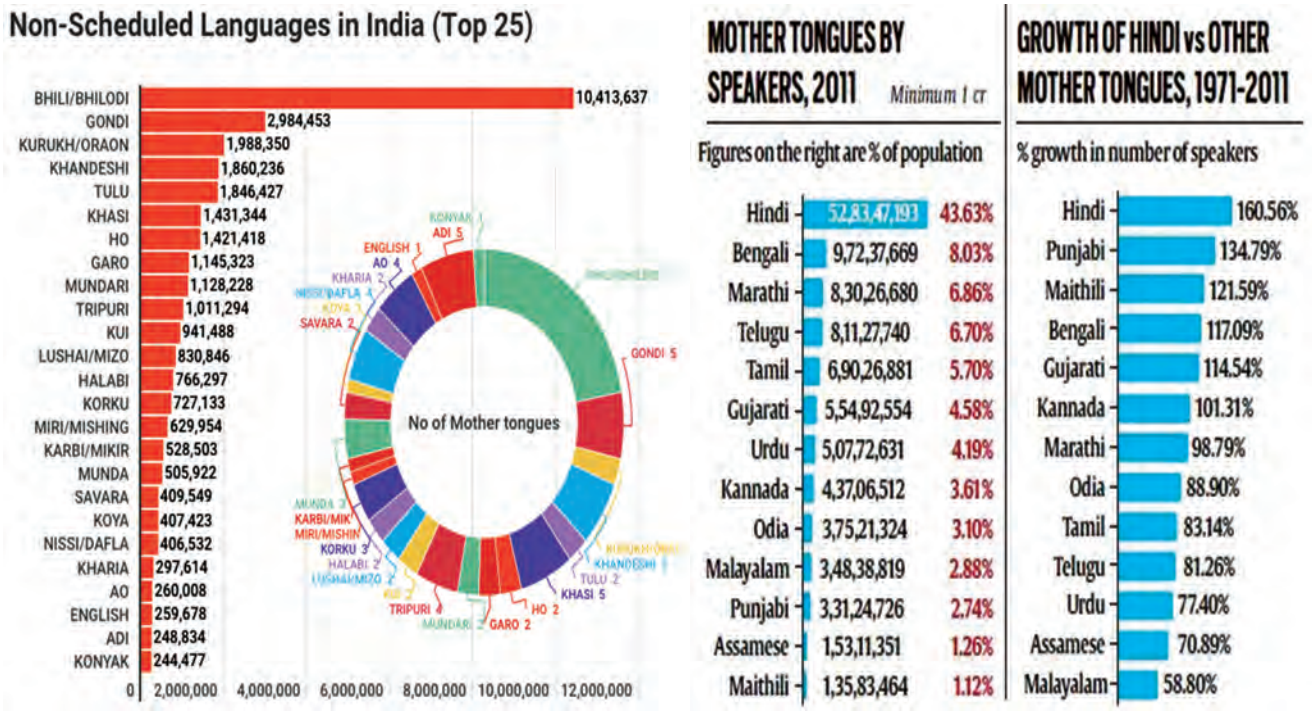


Fig. 5.29: Language Family and Speakers in India - 2011

According to 2011 census statistics on languages and **mother tongues, 3/4th of India's total population spoke Indo-Aryan languages**. Bengali (8.03 per cent), Marathi (6.86 per cent), Telugu (6.70 per cent), Tamil (5.70 per cent), Gujarati, Urdu, Kannada, Odia, Malayalam, Punjabi, Assamese, Maithili, Santali, Kashmiri, Nepali, Sindhi, Dogri, Konkani, Manipuri, Bodo, and Sanskrit followed. Although Sanskrit is spoken by over 25000 individuals, the fraction of people who speak it is quite small.

IGNITE YOUR MIND

Language Labyrinth: Over 6,000 languages paint the world's communication map. How do languages evolve, and what ethical considerations arise in promoting multilingualism?

Religious Composition

Religion is a **belief or worship system** that impacts how a person perceives, understands, and interacts with the world. A person's religious views are frequently their primary basis of their ethical and moral ideals/choices. Religion provides solace, and meaning, to many believers.

- Religion is a **collection of organised ideas, practises, and systems** that most commonly pertain to the belief and worship of a dominating power, such as a personal god or another supernatural being.
- **Hinduism (Majority Religion):** Nearly 80% of Indians adhere to Hinduism. Hinduism is the predominant religion in many states, ranging from 70-90%, except in specific regions near international borders and certain plateau and plain areas.

- **Islam and Christianity: Significant Minorities:** Approximately 14% of the population practices Islam. Christianity is followed by 2.3%, with concentrations in specific states and rural regions. Christian population is prominent in the western coast of Goa, Kerala, and hilly states like Meghalaya, Mizoram, Nagaland, Chotanagpur, and Manipur.
- **Sikhism's Concentrated Presence:** Sikhs constitute 1.7% of the population. Predominantly found in Punjab, Haryana, and a small portion of Delhi.
- **Buddhism's Historical Roots and Contemporary Presence:** Buddhism is widespread in East, Southeast, and South Asia due to King Ashoka's propagation efforts. Concentrated pockets in Sikkim, Arunachal Pradesh, Jammu & Kashmir, Ladakh, Tripura, and Himachal Pradesh's Lahul and Spiti. Buddhism also has a presence in Maharashtra.
- **Other Religious Groups and Indigenous Beliefs:** Other Indian religions include Zoroastrians, tribal, and indigenous beliefs. Small pockets of these tribes are distributed across the country.

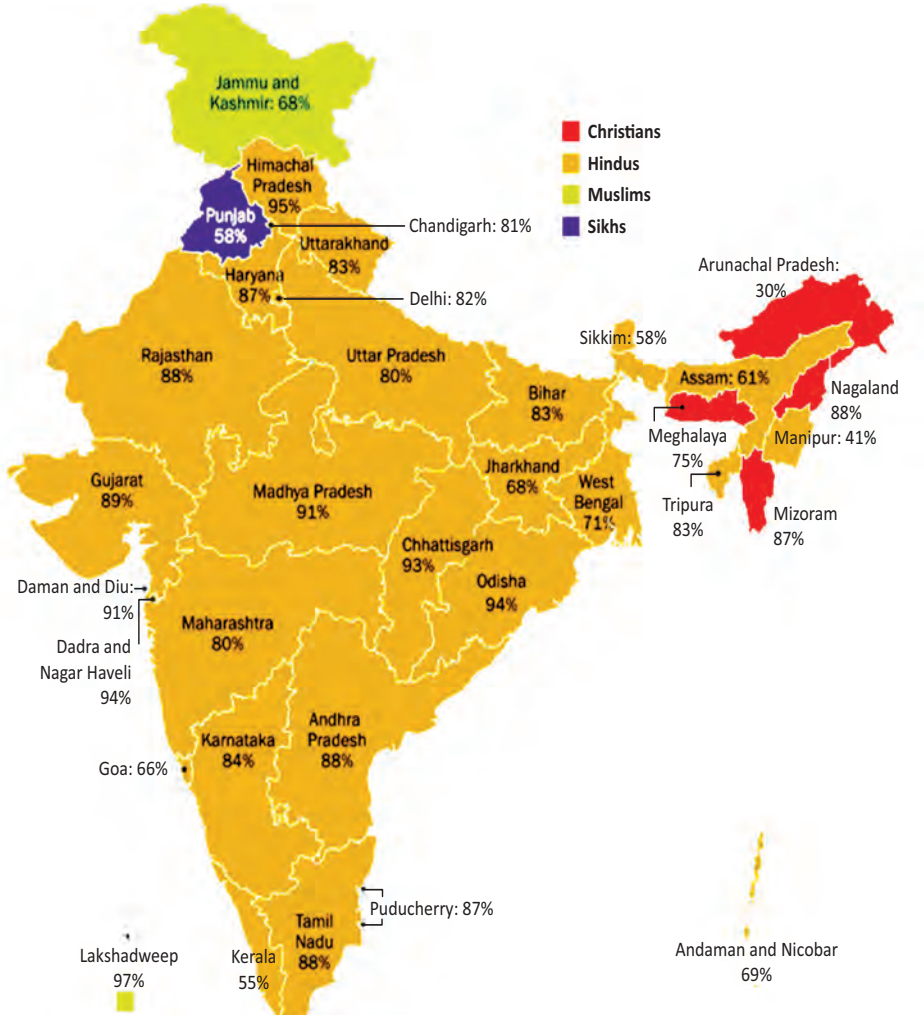


Fig. 5.30: Religious Composition of India(Census 2011)

Trends in Population Growth Rate Based on Religion

The rate of **religious population growth** has slowed during the recent decade (2001-2011). Hindu population growth rate dropped to 16.76% from 19.92% in the previous decade, while Muslim population growth rate fell sharply to 24.60% (2001-2011) from 29.52% (1991-2001).

- Such a dramatic **decline in the Muslim population** growth rate has not occurred in the previous six decades. **Christian population increase** was 15.5%, while Sikh population growth was 8.4%.
- The **most educated and prosperous group of Jains** saw the worst growth rate, with only 5.4% between 2001 and 2011.
- The growth rate of Hindus, Muslims, and Christians is predicted to reduce further in the approaching 2021 census, while other religions such as Sikhism, Jainism, and Buddhism are expected to remain steady for the next two decades due to these religions' already slower growth rate.

Literacy

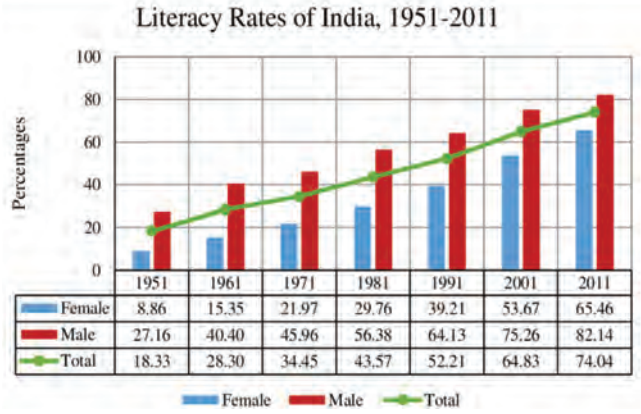
The literacy rate in India varies by state and gender. Kerala has the highest literacy rate at 94%, while **Bihar has the lowest literacy rate at 61.8%.** The literacy rate among men is 84.4%, while the literacy rate among women is 71.5%.

- When India gained freedom in 1947, the literacy rate was abysmal. Literacy was just 18% of the whole population. Female literacy was even lower (8.86%).

Spatial Pattern of Female Literacy

- Except for Andhra Pradesh (59.74%), the female literacy rate in other southern states, including Kerala (91.98%), Tamil Nadu (73.86%), and Karnataka (68.13%), are higher than the national average (65.46%). Most northern states, including Bihar (53.33%), Rajasthan (52.66%), Orissa (64.36%), Chhattisgarh (60.59%), Madhya Pradesh (60.02%), Jharkhand (56.21%), Jammu and Kashmir (58.01%), and Uttar Pradesh (59.26%), have lower female literacy rates than the national average (65.46%). Except

for Dadra and Nagar Haveli, the female literacy rate in all union territories (65.93%) is higher than the national average of India (65.46%). Except for Arunachal Pradesh, the female literacy rate in the northeastern states is higher than the national average (65.46%).



	1951	1961	1971	1981	1991	2001	2011
Female	8.86	15.35	21.97	29.76	39.21	53.67	65.46
Male	27.16	40.40	45.96	56.38	64.13	75.26	82.14
Total	18.33	28.30	34.45	43.57	52.21	64.83	74.04

Fig. 5.31: Trend of Literacy Rate

Workforce Population

The composition of the working population refers to the **distribution of workers by different categories,** such as age, sex, education, occupation, and industry. It is an important indicator of a country's economic development and social structure.

- The Indian population is classified by **economic position into three groups**: major workers, marginal workers, and non-workers.
- In India, just 39.8% of the population (main and marginal) are employed (2011), leaving a majority of 60% unemployed. This suggests a **higher share of the dependent population** and potential unemployment or underemployment.

State Wise Pattern of Literacy

- **Southern states:** They have the highest literacy rates in India. Kerala has the highest literacy rate in India at 94%, followed by Mizoram (91.58%), Goa (91.55%), Tripura (91.20%), and Himachal Pradesh (86.66%).
- **Northern states:** The lowest literacy rates in India. Bihar has the lowest literacy rate in India at 61.80%, followed by Jharkhand (66.41%), Rajasthan (69.61%), and Uttar Pradesh (71.68%).
- **Eastern states:** This region has moderate literacy rates, ranging from 64.36% in Odisha to 83.96% in Sikkim.
- **Western states**: They also have moderate literacy rates, ranging from 74.40% in Gujarat to 87.5% in Maharashtra.

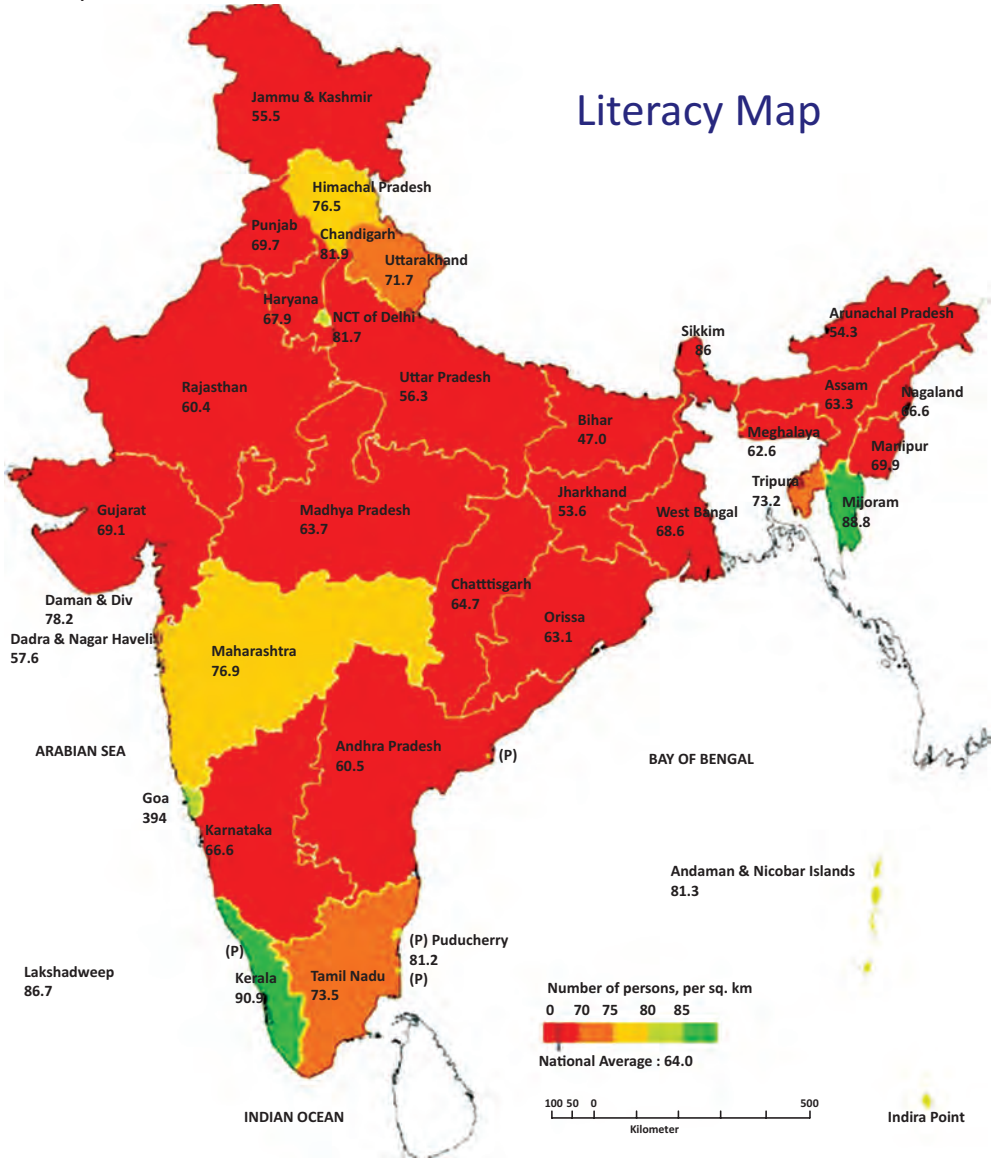


Fig. 5.32: State-wise Literacy Rates in India

IGNITE YOUR MIND

Automation Anxiety: Technology replaces jobs, raising concerns about mass unemployment. Automation and AI could disrupt jobs and economies. Explore the potential impact of automation on migration, labor markets, and social inequality. Can we adapt and create new opportunities? How can we ensure everyone benefits from technological advancements?

The working population is moderately varied between states and Union Territories, ranging from 39.6% in Goa to 49.9% in Daman and Diu.

- The states with the **highest worker percentages include** Himachal Pradesh, Sikkim, Chhattisgarh, Andhra Pradesh, Karnataka, Arunachal Pradesh, Nagaland, Manipur, and Meghalaya. In the Union Territories, Dadra and Nagar Haveli and Daman and Diu have greater participation rates.
- In India, the **work participation rate is greater in areas with lesser economic development** due to the necessity for manual workers for subsistence or near-subsistence activities.
- The occupational structure of a nation is the percentage of its workers working in various economic enterprises. The occupational structure of the nation may be used to determine the number of workers in agriculture and related fields and manufacturing and services.
- About **54.6% of the working population are cultivators and agricultural labourers,** while 3.8% work in household industries and 41.6% work in non-household industries, trade, commerce, building, repair, and other services. In all three sectors, men employees outnumber female workers in the country's male population.
- While **female employees are prevalent in the primary sector,** there has been a significant increase in their engagement in secondary and tertiary sectors. Over the past two decades, the share of agricultural employees in India has decreased from 58.2% in 2001 to 54.6% in 2011.

SECTOR WISE WORKFORCE (%) IN INDIA

YEAR	AGR	INDS	SERVICE
1901	71.8	12.6	15.6
1951	72.1	10.6	17.3
1961	71.8	12.2	16.0
1971	72.1	11.2	16.7
1981	68.8	13.5	17.7
1991	66.8	12.7	20.5
2001	56.7	17.5	25.8
2011	47.2	24.7	28.7

SOURCE: CENSUS OF INDIA & www.

Fig. 5.33: Workforce in India

Categories	Population			
	Persons	% to total Workers	Male	Female
Primary	36,30,22,473	54.6	16,54,47,075	9,75,75,398
Secondary	1,83,36,307	3.8	97,75,635	85,60,672
Tertiary	20,03,84,531	41.6	15,66,43,220	4,37,41,311

- The **involvement rate in secondary and tertiary sectors has increased**. This suggests a move from farm-based to non-farm-based jobs, indicating a sectoral change in the economy. According to Census 2011, females have a **labour participation rate of 25.51%,** while males have a rate of 53.26%. Female workforce participation in the rural sector is 30.02%, compared to 53.03% for males in the urban sector.

Do You Know?

- A **main worker** is an individual who engages in employment for a minimum duration of 183 days, or equivalently, six months, during a given calendar year.
- A **marginal worker** may be defined as an individual who is employed for a duration of less than 183 days, equivalent to six months, during a given calendar year.
- **Female labour force participation** is the percentage of women of working age who are either employed or actively seeking employment. It is an important indicator of gender equality and economic development.

Rural-Urban Composition

The population is classified into **two categories based on the size and occupation** of settlements: Rural And Urban. Communities living in the countryside, make up the rural population. People who reside in big settlements, such as towns and cities, make up the urban population.

- According to the Census 2011, India has 640,867 villages, of which 597,608 (93.2%) are inhabited villages. However, the rural population distribution is not homogeneous across the country. States with a **large proportion of rural residents** include Bihar and Sikkim.
- The **rural-urban movement** is most visible in urban regions along major road linkages and railroads in the North Indian Plains, as well as in industrial areas surrounding Kolkata, Mumbai, Bengaluru-Mysuru, Madurai-Coimbatore, Ahmedabad-Surat, Delhi-Kanpur, and Ludhiana-Jalandhar.
- The **degree of urbanisation** has remained low in agriculturally stagnant regions of the middle and lower Ganga Plains, parts of Telangana, non-irrigated Western Rajasthan, isolated hilly, tribal areas of the northeast, flood-prone areas of Peninsular India, and the eastern half of Madhya Pradesh.

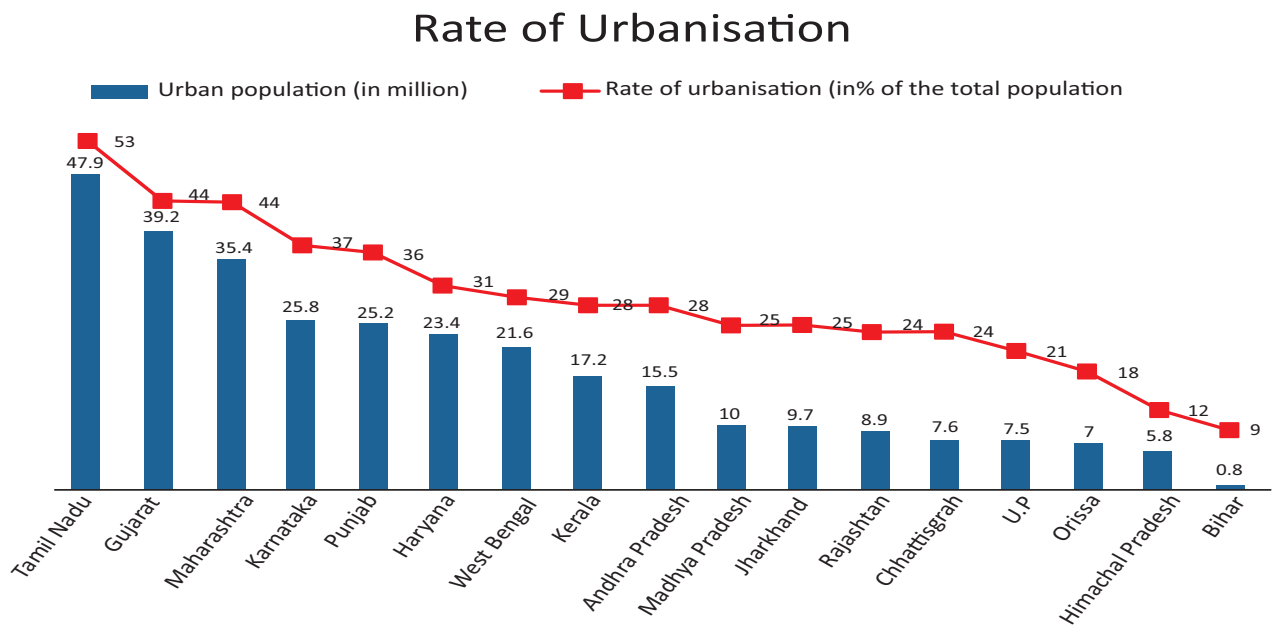


Fig. 5.34: Spatial Distribution of Urbanization in India as per the 2011 Census

- The **rural population increased** by 12.18% between 2001 and 2011. Since 1991, India's rural population has been continuously shrinking. Meghalaya (27%) and Bihar (24%) had the highest growth rates among states in 2001-11. During 2001-11, four states had a decrease in rural population.
- Except for Dadra and Nagar Haveli (53.38%), the Union Territories have a lower share of the rural population. The **size of settlements varies** greatly as well. It is less than 200 people in the hill regions of north-eastern India, Western Rajasthan, and Rann of Kuchchh, and as many as 17 thousand people in Kerala and portions of Maharashtra.

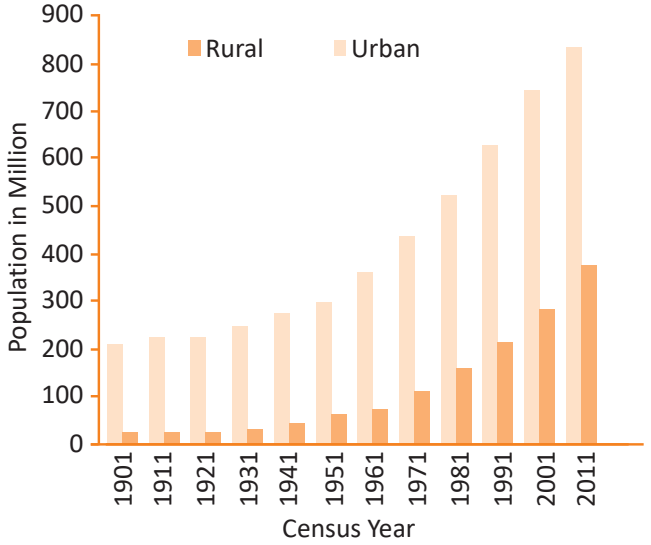


Fig. 5.35: Rural and Urban Population in India (1990-2011)

- A detailed **investigation of the pattern of distribution** of rural population in India demonstrates that the relative degree of urbanisation and breadth of rural-urban mobility govern the concentration of rural population at both intra-state and inter-state levels.

Reasons for Rural Decline of Population

- **Rising Urban Population:** The urban population has increased by 31.8 per cent since 2001, compared to an average growth rate of roughly 21.34 per cent.
- **Rural to Urban Migration:** However, this expansion is not completely attributable to natural population increase. In reality, the high pace of migration from rural to urban regions accounts for a major percentage of the urban population increase.
- **Shift in Occupation Structure**: People's jobs are gradually shifting from primary to secondary and tertiary sectors.
- **Expansion of Municipal Areas:** The limits of municipal or city corporations are routinely extended to incorporate neighbouring villages or suburbs.

Scheduled Castes in India

Scheduled castes, a **sub-community of the Hindu caste system**, have traditionally endured deprivation, discrimination, and social isolation due to their low status in India. The 2011 Census reports 16.63% of the Indian population, or 201,378,372 individuals, as scheduled castes.

- **Uttar Pradesh has the greatest proportion of scheduled castes** in its population. The population was 20.70% of the overall population of the state. In Uttar Pradesh, every fifth individual belongs to the scheduled caste group.
- **Punjab has the highest proportion of SCs,** accounting for 31.94 per cent of the total population. West Bengal has the second-highest number of scheduled caste people, followed by Bihar, Tamil Nadu, Andhra Pradesh, Maharashtra, Rajasthan, Madhya Pradesh, and Karnataka. The population of Arunachal Pradesh, Nagaland, Lakshadweep, and Andaman and Nicobar Islands did not include Scheduled Castes.

- Himachal Pradesh (25.19%) has a scheduled caste population of every fourth person. In West Bengal, 23.51% of the population includes scheduled castes. Every fifth individual in Uttar Pradesh, Tamil Nadu, and Haryana is a scheduled caste. The **largest percentage of scheduled castes** was seen in Koch Bihar (50.17%) and Shahid Bhagat Singh Nagar (42.51%) districts.

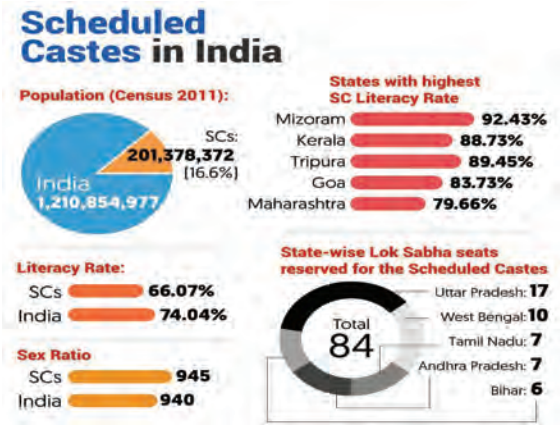


Fig. 5.37: Data on Scheduled Castes (SCs) Population in India

Tribes in India

Tribes are characterized by distinct **identity**, **dialect**, **cultural homogeneity**, and unified **social organization**. In India, tribes, also known as **Adivasis**, lack a definitive classification system and are studied based on various anthropological criteria.

Classification of Tribes

- **Permanent Traits:** Include factors such as **geography**, **language**, **physical attributes**, and **size**.
- **Non-Permanent or Acquired Traits:** Include factors such as **economy** and **integration into Hindu society**.

Characteristics of Tribal Community

- Tribal communities exhibit distinctive culture, collective identity, communal land ownership, rural livelihoods, animistic beliefs, and linguistic diversity.
- Socio-economic challenges include marginalization, limited access to basic amenities, socio-economic backwardness, and geographical isolation.

Population Statistics in India

- The tribal population constitutes **8.6%** of India's total population, with **97%** residing in rural areas.
- Decadal population growth from Census 2001 to 2011 was **23.66%**, with a higher **female-to-male sex ratio** observed.
- **Economic Activities:** Tribal economies involve diverse activities such as **hunting**, **fishing**, **gathering**, **shifting cultivation**, **lumbering**, **sedentary cultivation**, and **animal husbandry**.
- **Challenges Faced:** Challenges include **loss of control over natural resources**, **lack of education**, **health and nutrition issues**, and **gender disparities**.

Government Initiatives

- Constitutional provisions, reservations in **legislatures** and **Panchayats**, and representation in **services** aim to safeguard tribal rights.
- Government schemes, including **scholarships** and assistance to **voluntary organizations**, support tribal welfare and education.

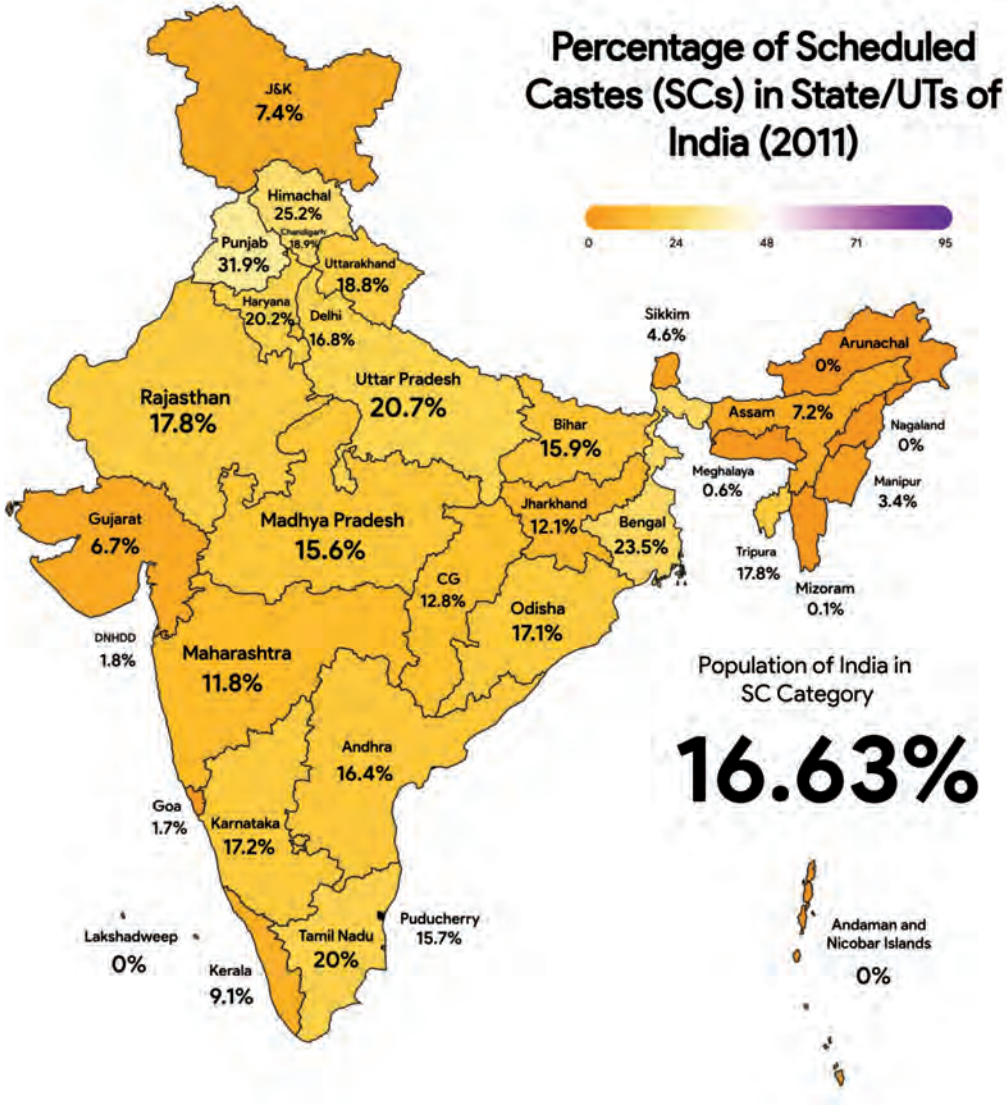


Fig. 5.36: State-wise Percentage of Scheduled Castes (SCs) Population in India

Government Bodies

- The **Ministry of Tribal Affairs**, established in **1999**, focuses on the socio-economic development of Scheduled Tribes.
- The **National Commission for Scheduled Tribes** advises on the planning and evaluation of socio-economic development programs.
- **Tribal Sub-Plan (TSP):** Aimed at rapid socio-economic development of tribal areas, ensuring funds proportionate to the tribal population of each state.

Tribes - State-wise Distribution in India

State/UT	Major Tribes
Andhra Pradesh	Andh, Sadhu Andh, Bhagata, Bhil, Chenchus, Gadabas, Gond, Goundu, Jatapus, Kammara, Kattunayakan, Kolawar, Kolam, Konda, Manna Dhora, Pardhan, Rona, Savaras, Dabba Yerukula, Nakkala, Dhulia, Thoti, Sugalis, Banjara, Kondareddis, Koya, Mukha Dhora, Valmiki, Yenadis, Sugalis, Lambadis.
Arunachal Pradesh	Apatanis, Abor, Dafla, Galong, Momba, Sherdukpen, Singpho, Nyishi, Mishmi, Idu, Taroan, Tagin, Adi, Monpa, Wancho.
Assam	Chakma, Chutiya, Dimasa, Hajong, Garos, Khasis, Gangte, Karbi, Boro, Borokachari, Kachari, Sonwal, Miri, Rabha, Garo.
Bihar	Asur, Baiga, Birhor, Birjia, Chero, Gond, Parhaiya, Santhals, Savar, Kharwar, Banjara, Oraon, Santal, Tharu.
Chhattisgarh	Agariya, Bhaina, Bhattra, Biar, Khond, Mawasi, Nagasia, Gond, Binjhwar, Halba, Halbi, Kawar, Sawar.
Goa	Dhodia, Dubia, Naikda, Siddi, Varli, Gawda.
Gujarat	Barda, Bamcha, Bhil, Charan, Dhodia, Gamta, Paradhi, Patelia, Dhanka, Dubla, Talavia, Halpati, Kokna, Naikda, Patelia, Rathawa, Siddi.
Himachal Pradesh	Gaddis, Gujjars, Khas, Lamba, Lahaulas, Pangwala, Swangla, Beta, Beda Bhot, Bodh.
Jammu and Kashmir	Bakarwal, Balti, Beda, Gaddi, Garra, Mon, Purigpa, Sippi, Changpa, Gujjar.
Jharkhand	Birhors, Bhumij, Gonds, Kharia, Mundas, Santhals, Savar, Bedia, Ho, Kharwar, Lohra, Mahli, Parhaiya, Santal, Kol, Banjara.
Karnataka	Adiyan, Barda, Gond, Bhil, Iruliga, Koraga, Patelia, Yerava, Hasalaru, Koli Dhor, Marati, Meda, Naikda, Soligaru.
Kerala	Adiyan, Arandan, Eravallan, Kurumbas, Malai arayan, Moplahs, Uralis, Irular, Kanikaran, Kattunayakan, Kurichchan, Muthuvan.
Madhya Pradesh	Baigas, Bhils, Bharia, Birhors, Gonds, Katkari, kharia, Khond, Kol, Murias, Korku, Mawasi, Pardhan, Sahariya.
Maharashtra	Bhaina, Bhunjia, Dhodia, Katkari, Khond, Rathawa, Warlis, Dhanka, Halba, Kathodi, Kokna, Koli Mahadev, Pardhi, Thakur.
Manipur	Naga, Kuki, Meitei, Aimol, Angami, Chiru, Maram, Monsang, Paite, Purum, Thadou, Anal, Mao, Tangkhul, Thadou, Poumai Naga.
Meghalaya	Chakma, Garos, Hajong, Jaintias Khasis, Lakher, Pawai, Raba, Mikir.
Mizoram	Chakma, Dimasa, Khasi, Kuki, Lakher, Pawi, Raba, Synteng, Lushai.
Nagaland	Angami, Garo, Kachari, Kuki, Mikir, Nagas, Sema, Ao, Chakhesang, Konyak, Lotha, Phom, Rengma, Sangtam.
Odisha	Gadaba, Ghara, Kharia, Khond, Matya, Oraons, Rajuar, Santhals, Bathudi, Bathuri, Bhottada, Bhumij, Gond, Juang, Kisan, Kolha, Kora, Khayara, Koya, Munda, Paroja, Saora, Shabar, Lodha.
Rajasthan	Bhils, Damaria, Dhanka, Meenas(Minas), Patelia, Sahariya, Naikda, Nayaka, Kathodi.
Sikkim	Bhutia, Khas, Lepchas, Limboo, Tamang.

Tamil Nadu	Adiyan, Aranadan, Eravallan, Irular, Kadar, Kanikar, Kotas, Todas, Kurumans, Malayali.
Telangana	Chenchus.
Tripura	Bhil, Bhutia, Chaimal, Chakma, Halam, Khasia, Lushai, Mizel, Namte, Mag, Munda, Riang.
Uttarakhand	Bhotias, Buksa, Jonsari, Khas, Raji, Tharu.
Uttar Pradesh	Bhotia, Buksa, Tharu, Kol, Raji, Gond, Kharwar, Saharya, Parahiya, Baiga, Agariya, Chero.
West Bengal	Asur, Khond, Hajong, Ho, Parhaiya, Rabha, Santhals, Savar, Bhumij, Bhutia, Chik Baraik, Kisan, Kora, Lodha, Kheria, Khariam, Mahali, Mal Pahariya, Oraon.
Andaman and Nicobar	Oraons, Onges, Sentinelese, Shompens.
Little Andaman	Jarawa.

Scheduled Tribes in India

According to The National Commission for Scheduled Tribes, India has around 700 Scheduled Tribes. The definition of "Scheduled Tribes" has been carried over from British-era legislation, as has the term for "Scheduled Castes."

- According to the **National Commission for Scheduled Tribes**, the features that separate Scheduled Tribe populations in our nation from other communities include primitiveness, geographical isolation, shyness, and social, educational, and economic backwardness as a result of these factors.
- Concerning the states of Haryana and Punjab, as well as the Union Territories of Chandigarh, Delhi, and Puducherry, no group has been designated as a Scheduled Tribe. While some tribal communities have adopted a mainstream way of life, there are 75 Scheduled Tribes known as **Particularly Vulnerable Tribal Groups** (PVTGs) that are characterised by, pre-agriculture level of technology, stagnant or declining population, extremely low literacy, and subsistence level of economy.
- According to the 2011 census, the **country's tribal population** is 10.45 crore or 8.6 per cent of the overall population. Nearly 90 per cent (89.97%) of them reside in rural areas, while 10.03 per cent dwell in metropolitan areas.
- From Census 2001 to 2011, **tribal population growth** was 23.66 per cent, compared to 17.69 per cent for the whole population. The overall sex ratio of India is 943 females for every thousand males, whereas Scheduled Tribes have a sex ratio of 990 females for every thousand men.
- **The Scheduled Tribes are mostly found in two geographical areas**, Central India and the North-Eastern Area. More than half of the Scheduled Tribe population is concentrated in Central India, specifically Madhya Pradesh (14.65 percent), Maharashtra (10.05 percent), Odisha (9.17 percent), Rajasthan (8.84 percent), Gujarat (8.53 percent), Jharkhand (8.27 percent), Chhattisgarh (7.48 percent), Andhra Pradesh (5.66 percent), and West Bengal (5.07 percent). The North-East, which includes Assam, Nagaland, Mizoram, Manipur, Meghalaya, Tripura, Sikkim, and Arunachal Pradesh, are other unique region. On the other hand, states/Union Territories such as Goa, Lakshadweep, Andaman and Nicobar Islands, and Daman and Diu have a very low share of the country's scheduled tribal population.

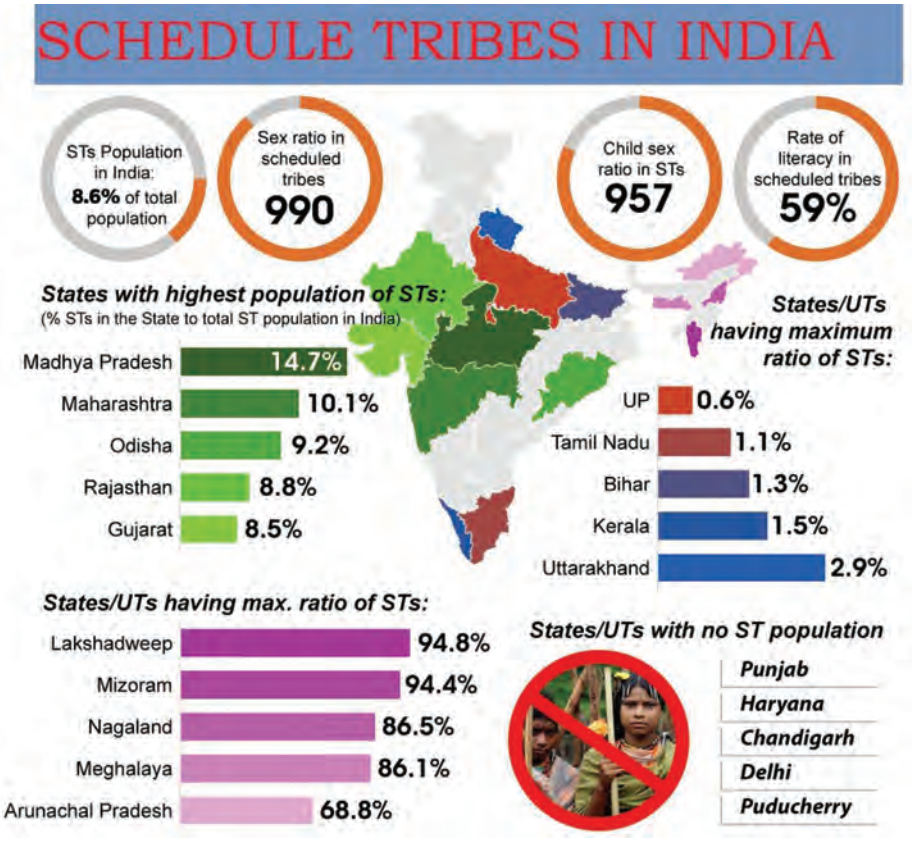


Fig. 5.38: Data on Scheduled Tribes (STs) Population in India

Constitutional Provisions for STs	
Article	**Description**
Article 29	Protects the distinct language, script, or culture of minorities.
Article 350A	Mandates adequate facilities for **mother-tongue instruction** at the primary stage of education.
Sixth Schedule Art. 244	Governs administration of tribal areas in northeastern states: **Assam**, **Meghalaya**, **Tripura**, **Mizoram**.
Fifth Schedule Art. 244(1)	Defines **scheduled areas**, specified by the President, covering 10 states in India.
Article 275(1)	Provides **grants-in-aid** to states with scheduled tribes in the fifth and sixth schedules.
Article 46	Directs the state to promote **educational and economic interests** of weaker sections, particularly **scheduled castes** and **scheduled tribes**.
Legislative Provisions for Protection of STs	
Legislation	**Description**
The Andaman and Nicobar (Protection of Aboriginal Tribes) Regulation, 1956	Provides protection to the **Sentinelese** and other aboriginal tribes in the **Andaman and Nicobar Islands**.
Exclusion of 30 islands from Restricted Area Permit (RAP)	In August 2018, the **Ministry of Home Affairs** excluded 30 islands from the **Restricted Area Permit (RAP)** regime, including the **North Sentinelese Island**.
The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (FRA)	Recognises forest and habitat rights of the forest dwelling tribal communities and other traditional forest dwellers.
The Provisions of the Panchayats (Extension to the Scheduled Areas) Act, 1996 (PESA)	Extends the national **Panchayat framework** to **Scheduled Areas**, excluding certain regions, promoting **self-governance**.
Foreigners (Restricted Areas) Order, 1963	Declares the **Andaman & Nicobar Islands** a **Restricted Area** where foreigners with permits can stay.
Andaman and Nicobar Islands (Protection of Aboriginal Tribes) Regulation, 1956	Protects **PVTG habitats** in the **Andaman and Nicobar Islands** with **Tribal Reserves**.

PARTICULARLY VULNERABLE TRIBAL GROUPS (PVTGS)

PVTGs (Particularly Vulnerable Tribal Groups) are more vulnerable among the tribal groups. Due to this factor, more developed and assertive tribal groups take a major chunk of the tribal development funds, because of which PVTGs need more funds directed for their development.

- In 1975, the **Indian Government declared 52 tribal groups as PVTGs.**
- In 1993, **23 groups were added to the list.**
- Hence, there are **75 PVTGs out of 705 Scheduled Tribes.**
- **Odisha** has the highest number of PVTGs. In 2020, the Odisha government further identified **888 villages/ hamlets inhabited by PVTGs.**
- **2.8 million PVTGs** in **75 tribes** across **22,544 villages** in **220 districts** across **18 states and Union Territories**.
- The PVTGs are spread over **18 states and one Union Territory (UT), in the country (2011 census)**.

Characteristics of PVTGs

- **Pre-agricultural technology:** Reliance on traditional hunting, gathering, and fishing practices.
- **Homogeneity:** Small, culturally and linguistically unique communities.
- **Stagnant or declining population:** Factors include low birth rates, high mortality, and out-migration.
- **Physical isolation:** Located in remote regions, challenging access to essential services.
- **Extremely low literacy:** Limited education opportunities.
- **Slow rate of change:** Resistance to adopting new technologies and practices.
- **Subsistence economy:** Reliance on traditional livelihoods.

Five Major PVTGs of India

There are **730 distinct ethnic groups**, etc., that have been notified as Scheduled Tribes from 30 States and UTs. The most well-known Indian tribes are the **Santhal, Munda, Gonds, Bhils (or Bheels), Bhutia, Chenchu, Tharu, Raji, Kodaba, Khasi, Garo, Angami, and the Great Andamanese Tribes**. Santhal, Munda, Gonds, Bhils (or Bheels), Bhutia, Chenchu, Kodaba, Khasi, Garo, Gonds, Gaddi, Todas, Totos, Munda, and the Great Andamanese Tribes are the most well-known Indian tribes. Let us take a look at some of India's most important tribes or tribal groups:

- **Bhils Tribe**
  - One of the oldest and largest tribal groups in India, they are found in Madhya Pradesh, Maharashtra, Gujarat, Chhattisgarh, Rajasthan, Karnataka, and Andhra Pradesh. They are well-known archers with extensive knowledge of their surroundings. They were traditionally experts in guerrilla warfare, but the majority of them are now farmers and agricultural laborers. The name derives from the word '**billu**,' which means bow.
  - **Bhil** is India's most populous tribe, accounting for **37.7% of all Scheduled Tribes (2011 Census)**. Their population is concentrated in the state of **Madhya Pradesh**, and they are an Indo-Aryan-speaking inherited group in West India.
  - They are classified as **Bhil Garasia, Vasave Bhil, Pawra Bhil, and Tadai Bhil**.
- **Gonds Tribe**
  - The **Gonds**, the second-largest tribal group in India, are primarily found in the states of **Uttar Pradesh, Jharkhand, Chhattisgarh, Madhya Pradesh, Maharashtra, Gujarat, West Bengal, Andhra Pradesh, Karnataka, and Telangana**. They are members of the South Central branch of the Dravidian language family, specifically the Gondi-Manda subgroup. The word '**Gond**' comes from the Telugu word '**Konda**,' which means hill.
  - **Gonds tribe** is India's second most populous tribe, accounting for **35.6% of all Scheduled Tribes (2011 Census)**.
  - The **Gond Tribe has the highest population in Chhattisgarh**.
- **Munda Tribe**
  - The **Munda** are an **Indian primarily located in Chotanagpur plateau** they live in Jharkhand, Chhattisgarh, Madhya Pradesh, Odisha, Tripura, and West Bengal states of India. The majority of the Munda tribe, also known as 'Horoko,' live in India. The language they speak is also called 'Munda.' The language belongs to the Austroasiatic language family.
  - The majority of the Munda tribe, also known as '**Horoko,**' lives in India.
- **Santhal Tribe**
  - The **Santhal tribe** is one of the major tribes in India, mainly in the states of **Jharkhand, Bihar, West Bengal, and Odisha**. The Santhal community is known for its traditional music and dance, and they have a rich cultural heritage.
- **Bhutia Tribe**
  - The **Bhutia tribe** is one of the prominent tribal groups in India, residing mainly in the northern states of **Sikkim and West Bengal**.
  - The Bhutias are known for their distinct culture, language, and traditions.
- **Issues Faced by PVTGs:** Marginalization, land alienation, health, livelihood, education, cultural erosion, vulnerability to disasters, lack of political representation

PVTG Schemes and Programs:

- Development of Particularly Vulnerable Tribal Groups (PVTGs)
- Vanbandhu Kalyan Yojana
- Eklavya Model Residential Schools
- Tribal Sub Plan
- National Rural Livelihood Mission
- National Health Mission

Recent Developments and Initiatives:

- Union Minister for Tribal Affairs, Shri Arjun Munda, emphasizes a **mission mode approach for PVTG development**.
- Ministry of Tribal Affairs implements the '**Development of Particularly Vulnerable Tribal Groups (PVTGs)**' scheme.
- Aims for comprehensive socio-economic development while preserving culture and heritage.
- Allocation of Rs **15,000 crore for the socio-economic development of PVTGs** over the next three years.
- Designing an **HDI survey to gauge the development index specifically for PVTGs**.
- **Reproductive Rights and Government Measures:** Importance for overall well-being and development, government measures include special outreach services, awareness campaigns, financial assistance, strengthening health infrastructure, and ensuring representation.

National Advisory Council Recommendations:

- Specially designed census for PVTGs covering remuneration, health, education, and housing.
- Generate awareness and continuously monitor **Forest ACT and PESA in PVTGs**.
- Educate tribal people about various laws, including **PESA and FRA**.

Conclusion

- Upholding **Tribal Panchsheel values** for integration at their own pace.
- Implementation of recommendations and collaborative efforts for addressing unique challenges faced by **PVTGs in India**.

STATE WISE DISTRIBUTION OF PVTGs	
State/UT	PVTGs
Andhra Pradesh (+ Telangana)	1. Chenchu, 2. Bodo Gadaba, 3. Gutob Gadaba, 4. Dongaria Khond, 5. Kutia Kondha, 6. Kolam, 7. Konda Reddi, 8. Kondasavara, 9. Bondo Porja, 10. Khond Porja, 11. Parengi Porja, 12. Tothi
Bihar (+ Jharkhand)	13. Asur, 14. Birhor, 15. Birjia, 16. Hill Kharia, 17. Korwa, 18. Mal Paharia, 19. Parhaiya, 20. Sauria Paharia, 21. Savara
Gujarat	22. Kolgha, 23. Kathodi, 24. Kotwalia, 25. Padhar, 26. Siddi
Karnataka	27. Jenu Kuruba, 28. Koraga
Kerala	29. Cholanaikayan, 30. Kadar, 31. Kattunayakan, 32. Koraga, 33. Kurumbas
Madhya Pradesh (+ Chattisgarh)	34. Abujh Maria, 35. Baiga, 36. Bharia, 37. Birhor, 38. Hill Korba, 39. Kamar, 40. Sahariya
Maharashtra	41. Katkaria /kathodi, 42. Kolam, 43. Maria Gond
Manipur	44. Maram Naga
Odisha	45. Chukutia Bhunjia, 46. Birhore, 47. Bondo, 48. Didayi, 49. Dongaria Khond, 50. Juang, 51. Kharia, 52. Kutia Kondha, 53. Lanjia Saura, 54. Lodha, 55. Mankirdia, 56. Paudi Bhuiya, 57. Saura
Rajasthan	58. Saharia
Tamil Nadu	59. Kattunayakan, 60. Kota, 61. Korumba, 62. Paniyan, 63. Toda
Tripura	64. Raing
Uttar Pradesh (+ Uttarakhand)	65. Buksa, 66. Raji
West Bengal	67. Birhor, 68. Lodha, 69. Totos
Andaman & Nicobar Islands	70. Great Andamanese, 71. Jarawa, 72. Onge, 73. Sentinelese, 74. Shompen, 75. Nicobarese

POPULATION PROBLEMS IN INDIA

- **Uneven Population Distribution**: India's population is not evenly distributed across the country. The majority of the population lives in the northern and eastern parts of the country, while the southern and western states are less densely populated. This uneven distribution is putting a strain on resources in some areas, such as water and land.
- **Rapid Urbanisation:** In 1951, only 17% of Indians lived in urban areas. By 2030, it is estimated that 50% of Indians will live in urban areas. This rapid urbanisation is putting a strain on urban infrastructure, such as housing, transportation, and sanitation.
- **Overpopulation**: India is one of the most populous countries in the world, with a population exceeding 1.4 billion. The high population density in many areas puts immense pressure on resources, infrastructure, and services. Overpopulation can lead to the depletion of natural resources, such as water, food, and energy. Overpopulation is widening the supply-demand mismatch, raising the price of food, housing, and healthcare and increasing the cost of living. This can make it difficult for people to meet their basic needs.
- **Environmental Stress**: The growing population in India has put considerable stress on natural resources, leading to environmental challenges such as deforestation, soil erosion, water scarcity, and pollution. This can damage ecosystems and make it difficult for people to live healthy lives.
- **Strained resources**. As the population grows, there is an increased demand for food, water, land, housing, and other essential resources. This can lead to scarcity and higher prices, making it difficult for people to afford the basics of life. Only 1% of Earth's water is fresh and usable. Overpopulation strains freshwater supplies everywhere.
- **Pandemic epidemiology**: Due to environmental and socioeconomic variables such as living in overcrowded and unclean conditions, malnutrition, and lack of healthcare, poor individuals are more likely to get infectious illnesses. Dense populations increase the risk of future pandemics and epidemics.

IGNITE YOUR MIND

Pandemic Preparedness: How do population density, migration patterns, and healthcare systems impact the spread of infectious diseases? Can we prepare for future outbreaks? How can we strengthen global health systems to prevent and respond effectively to future pandemics?

- **Limited Access to Education and Healthcare**. When governments are struggling to provide for a growing population, they may have to cut spending on education and healthcare. This can make it difficult for people to get the education and healthcare they need to improve their lives and break out of poverty.
- **Unemployment**. A growing population can lead to increased competition for jobs. This can make it difficult for people to find work, especially those who are unskilled or uneducated. Overall these factors lead to poverty which pushes us into a spiral of overpopulation. The Centre for Monitoring Indian Economy (CMIE), a private organization, estimates India's unemployment rate in India is around 7.95% at present. It is 7.93% in urban India whereas only 7.44% in rural India.
- **Ageing Population:** According to the UNFPA's India Ageing Report 2017, the percentage of people over 60 might rise from 8% in 2015 to 19% in 2050. The rising population and old age dependents would make it harder for India to provide jobs, education, health, and geriatric care.

IGNITE YOUR MIND

Ageing Enigma: An ageing population presents both challenges and opportunities. How can we harness the "silver economy" while ensuring support for retirees and fostering intergenerational solidarity?

POPULATION POLICY OF INDIA

- **Pre-Independence Phase:** No organized population control efforts before 1947.
- **Period of Neutrality (1947-1951):** Focus on post-independence issues, such as rehabilitation, state reform, and Kashmir invasion.
- **Initial Decades of Independence (1951-1961):**
  - National Family Planning Programme launched in 1952.
  - **Goal:** "Reduce birth rates to stabilize the population."
  - Experimental basis with Rs. 65 lakh in the First Plan and Rs. 5 crore in the Second Plan.
- **Population Control Initiatives in the 1960s and 1970s:**
  - Family planning gains national priority in the 1960s.
  - Introduction of the Extension Approach to Family Planning in the Third Plan (1966).
  - Ministry of Health establishes a separate Department of Family Welfare in 1966.
  - **Goal by 1980-81:** Lower birth rate to 25 per 1000 people.
- **National Population Policy (1976):**
  - Advocacy for national commitment to family planning.
  - Quantitative goals for reducing birth rate.
  - Legal measures, including disqualification for those with more than two children from holding public office.
  - Minimum age for marriage: 21 for males, 18 for females.
  - Emphasis on maternal and child health, education, and communication.
  - Economic incentives and disincentives.
- **Criticisms:**
  - Coercive measures during the Emergency period (1975-77).
  - Lack of addressing social determinants like poverty and illiteracy.
  - Uneven implementation across states and regions.
- **Analysis of Policy:**
  - Limited impact on population growth rates.
  - Coercive aspects rolled back post-Emergency.
  - New Population Policy in 1977 with focus on voluntary sterilization and media propagation.
  - Marriage age set at 18 for girls and 21 for boys.
  - **Result:** Decrease in sterilizations from 82.6 million in 1976-77 to 9 million in 1977-78.

National Population Policy (2000)

The National Population Policy(NPP) of 2000, instituted by the Government of India, **serves as a policy framework designed** to tackle the challenges associated with population growth and family planning within the nation.

Objectives of NPP 2000

1. **The Immediate Goal:** The immediate goal is to address unmet contraceptive, health care infrastructure, and health staff requirements, as well as to offer integrated service delivery for basic reproductive and child health care.
2. **The Medium-Term Goal**: The medium-term goal is to raise the Total Fertility Rate (TFR) to replacement levels by 2010 through aggressive adoption of cross-sectoral operational measures.
3. **The Long-Term Goal:** The long-term goal is to establish a stable population by 2045 that meets the objectives of sustainable economic growth, social development, and environmental preservation.

NPP 2000 Strategies

- Providing **universal access to quality reproductive health care services**, including family planning, safe abortion, and maternal and child health care.
- **Empowering women** through education, economic opportunities, and participation in decision-making.
- Addressing the **socio-cultural factors** that contribute to high fertility, such as early marriage and childbearing, and son preference.
- **Involve men in family planning** and reproductive health.
- **Strengthening the capacity of the health system** to deliver reproductive health care services.

To implement the policy a **National Population Commission** was formed, presided over by the Prime Minister. Its members include the chief ministers of all states and other relevant ministers. Every state to have a State Commission on Population led by the chief minister and the policy to be implemented at the grassroots level through Panchayats and Municipalities (PRIs).

Analysis of National Population Policy of 2000

The NPP 2000 has been successful in achieving some of its objectives. For example. The Total Fertility Rate has declined from 2.9 to 2.2 from 2005 to 2018 (SRS).

- The TFR has declined from 2.9 in 2000 to 2.3 in 2021.
- The unmet need for contraception has declined from 12% in 2000 to 8% in 2021.
- The maternal mortality ratio has declined from 300 per 100,000 live births in 2000 to 130 per 100,000 live births in 2021.
- The infant mortality rate has declined from 74 per 1,000 live births in 2000 to 32 per 1,000 live births in 2021.

Issues with the Policy

- The policy had a narrow focus since it prioritised contraception and sterilisation above key prerequisites for population control, such as poverty reduction, improved living conditions, and the expansion of education.
- The policy was not blocked and ignored to develop mass assistance for populace control.
- We have an insufficient framework due to a lack of prepared employees, insufficient fitness among the staff, and restricted usage or misuse of the hardware.

The NPP 2000 has **not been able to achieve its target** of bringing the TFR to replacement levels by 2010. This is due to **several factors, including** the lack of political will, inadequate funding, and the persistence of socio-cultural barriers to family planning.

The government of India is currently in the process of formulating a **new National Population Policy.** The new policy is expected to take into account the lessons learned from the NPP 2000 and to adopt a more comprehensive approach to population management.

Recent Debate Over Population Policy in India

The recent debate over the population policy of India has been sparked by several **factors, including**

- The passage of **population control bills in the states of Uttar Pradesh and Assam** would impose restrictions on the benefits and opportunities available to people with more than two children.
- The increasing political polarization in India has led to some politicians using population control as a way to mobilize their supporters.
- **The Haryana Population Control Bill, 2021** is a proposed law that would impose a two-child policy on couples in the state of Haryana. The bill has been met with mixed reactions, with some people supporting it and others opposing it.
- The **bill proposes to provide incentives** for couples who adhere to the two-child policy, such as tax breaks, preference for government jobs, and subsidized education. It also proposes to impose disincentives on couples who have more than two children, such as a fine of Rs. 50,000, denial of government jobs and subsidies, and debarment from contesting local body elections.
- The bill has been **criticized by some people for being discriminatory and for violating individual rights**. They argue that it would disproportionately affect poor and marginalized communities and that it would be difficult to enforce. Others have argued that the bill is necessary to control the state's population growth and to improve the quality of life for all Haryanans.

The bill has been **challenged in the Supreme Court by several organizations,** including the All India Democratic Women's Association and the National Alliance of People's Movements. The petitioners have argued that the bill is unconstitutional and that it violates the fundamental rights to equality and privacy.

National Family Health Survey (NFHS)
❑ It is a large-scale, multi-round survey conducted in a representative sample of households throughout India. It provides state and national information for India on fertility, infant and child mortality, the practice of family planning, maternal and child health, reproductive health, nutrition, anaemia, utilisation and quality of health and family planning services. ❑ The National Family Health Survey 5 (NFHS-5) is the fifth in a series of surveys conducted by the Ministry of Health and Family Welfare (MoHFW) in India. It was conducted in two phases, from June 2019 to April 2021. The survey covered a representative sample of 636,699 households, 724,115 women, and 101,839 men.

POPULATION CONTROL MEASURES BY GOVERNMENT

- **Mission Parivar Vikas**: The government has started Mission Parivar Vikas to significantly increase access to contraception and family planning services in 145 high fertility districts with TFRs of 3 and above in seven high-priority states. These districts are located in Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh, Chhattisgarh, Jharkhand, and Assam, which together account for 28% of the country's population.
- **New Contraceptive Options:** Injectable contraceptives and Centchroman have been introduced to the current contraceptive options. Post-partum IUCD (PPIUCD) is a novel approach to inserting an IUCD shortly after delivery.
- **Redesigned Contraceptive Packaging:** Condom, OCP, and ECP packaging has been updated and redesigned to promote demand for these commodities.
- **Compensation System For Sterilisation**: Under the scheme, the MoHFW compensates the recipient for wage loss as well as the service provider (& team) for performing sterilisations.
- **The Clinical Outreach Teams (COT) Scheme:** It was introduced in 146 Mission Parivar Vikas districts to provide family planning services through mobile teams from approved organisations in remote, underserved, and difficult-to-reach regions.
- **Family Planning Logistic Management and Information System (FP-LMIS)**: A specialised programme designed to enable the efficient forecasting, procurement, and distribution of family planning commodities across all levels of health care.
- **The National Family Planning Indemnity Scheme (NFPIS):** It ensures customers in the case of death, complication, or failure following sterilisation.

Other Measures Needed to Control Population

- **Increasing Legal Age of Marriage:** Raising the legal age of marriage from 18 to 21 for girls and for boys, 21 to 23 will help in arresting the rate of fertility and it will also improve the health of women and children.
- **Increasing Literacy:** It will contribute to achieving long-term goals of population stabilization by improving awareness in people about family planning and the importance of small families. It also helps in increasing the adverse sex ratio and India will be able to reap the fruit of the demographic dividend.
- **Empowering Women:** Increasing the agency of women will help increase their reproductive rights and give them bodily integrity to decide when to conceive. This will help to reduce maternal and infant mortality rates and achieve a stable population.
- **Improving Healthcare Infrastructure:** It will help in reducing the death rate among children as the population facing degraded healthcare facilities tends to reproduce more to compensate for the death of their neonates.

POPULATION EDUCATION

According to UNESCO, "Population Education aims to develop learners' knowledge, skills, attitudes, and values that will enable them to make informed decisions about population events and issues that will affect their quality of life and that of their society, both now and in the future.

Population Education has the following goals

- **Family Planning:** It is beneficial to comprehend how family size may be limited since population limitation can aid in the development of a greater quality of life in the country.
- **Awareness about the Impact of Overpopulation**: It helps in understanding the impact of population trends on different elements of human life - social, cultural, political, and economic.
- **Improving Access to Population Control Means:** Having a better grasp of technological and medical advancements that will allow us to gain more control over famines, illnesses, and, eventually, death, as well as the resulting imbalance between the death and birth rates.

Recognising the potential of education in addressing the issues of a growing population, the Ministry began a **Population Education Programme in 1980,** intending to incorporate Population Education into the official education system. The programme has been **supported by the Government of India, NCERT, and UNESCO** and is available to 143 million students in primary, secondary, and upper secondary schools across the nation.

MIGRATION

Migration is the **permanent or semi-permanent relocation of a person or group of people** over a long distance. It may be international, intra-national, interregional, intra-urban, rural-to-urban, or urban-to-rural. It might be a long or short distance based on the distance.

- Individual or mass migration may occur, depending on the amount of people involved, and the cause may be political or voluntary. Migration might take the form of a family, a community, a clan, or an individual, depending on the social organisation.
- Migration can be economic, social, cultural, religious, or political. Migration can occur in stages throughout time, or it can occur directly from the point of origin to the point of destination.

- Migration is enumerated in the Census of India on two bases:
  - Place of birth, if the place of birth differs from the place of enumeration (known as lifetime migrant); and
  - Place of residence, if the place of last residence differs from the place of enumeration (known as migrant by place of last residence).

Causes of Migration

Migration from rural to urban regions in India is driven by poverty, population pressure, and lack of essential infrastructure such as health care and education. Additionally, **natural calamities including** floods, droughts, cyclonic storms, earthquakes, tsunamis, wars, and local disputes might act as a push factor for migration.

- However, there are **forces that pull individuals from rural regions to cities**. Most rural migrants go to metropolitan regions seeking better chances, regular jobs, and greater salaries. Educational prospects, health facilities, and entertainment options are also significant pull factors.

Push and Pull Factors of Migration

Pull Factors	Push Factors
These factors attract migrants to an area (area of destination).	These factors compel migration to a new area.
Better job opportunities like higher wages, facilities, and better working conditions.	Lack of job opportunities and low wages.
Access to services like better employment opportunities, health services, education and better quality of life.	Few services like poverty, unavailability of quality health services and educational opportunities.
More entertainment facilities and a cheerful life.	Unhappy life as people migrate from areas having no or less development because of economic hardship and dissatisfaction.
Improved transportation facility and connectivity.	Poor transport connectivity.
Family links; people visit their relatives and sometimes use their influence to get a job or enrolment in educational instructions for their betterment of life.	Shortage of food like low agricultural productivity etc.

Besides push and pull factors, social and **cultural factors** also influence migration. Family disputes might induce migration. Better communication facilities, including transportation, radio, television, cinema, urban education, and changing views and values, contribute to migration. Some **political factors** encourage or discourage migration. The "**Sons of the Soil**" policy adopted by state governments in our nation will impact migration from other states.

Important Concepts Related to Migration

- **Internal migration:** This is the movement of people within a country, from one region to another. It is often motivated by economic opportunities, but can also be driven by political, social, or environmental factors.
- **International migration**: This is the movement of people between countries. It is often motivated by economic opportunities, but can also be driven by political, social, or environmental factors.
- **Forced migration:** This is the movement of people who are forced to leave their homes due to war, persecution, or natural disasters. It is often a very traumatic experience and can have a lasting impact on the lives of those who are displaced.
- **Refugees**: These are people who have been forced to flee their home country due to war, persecution, or natural disasters. They are often granted refugee status in another country, which gives them protection and allows them to start a new life.
- **Migrants**: These are people who have moved to another country, but do not have refugee status. They may be seeking economic opportunities, reuniting with family members, or simply looking for a better life.
- **Immigrants**: These are people who have been granted permanent residency in another country. They are often able to work, study, and live in the country without restrictions.
- **Diaspora**: This is a group of people who have been dispersed from their original homeland. They may maintain ties to their homeland, even if they have been living in another country for many years.
- **Assimilation**: This is the process by which immigrants adopt the culture and values of the country they have moved to. It is a gradual process and can be difficult for some people.

- **Integration**: This is the process by which immigrants become part of the fabric of the society they have moved to. It involves learning the language, participating in civic life, and building relationships with people from different backgrounds.
- **Migration Based on Distance:** Migration inside the district is referred to as "short-distance" migration, travel within the state across the district is referred to as "medium-distance" migration and migration beyond state lines is referred to as "long-distance" migration.

IGNITE YOUR MIND

Migration Maze: From refugees fleeing war to skilled workers seeking opportunities, migration shapes our world. Should countries prioritize open borders or stricter controls? How can we address the ethical dilemmas and ensure integration? How can we ensure fair and ethical migration policies that benefit both sending and receiving countries?

WORLD MIGRATION TRENDS

Throughout cultural history, there has been a clearly defined timeframe that interprets the practical importance of the Mobility Transition Model.

- Within the specific classification of significant migration patterns, both historical and contemporary trends are included.
- **Zimolzak and Stanshield** initially established the understanding of the human dimension of the Second World War through their publication titled **"Human Landscape."**

Historical Migration

- Historical migration refers to movements that occurred before 1945.
- It often **involved large-scale population shifts** across international borders, driven by various factors and resulting in diverse outcomes.
- Within historical migration, there are distinct types of movements that significantly influence cultural, demographic, and economic aspects: **Voluntary migration, Economic migration,** and **Forced migration.**

Voluntary migration

- This migration entails European settlers relocating to foreign lands.
- The **destinations included** Anglo-America, the Cape Province of South Africa, the Eastern Highlands of Africa, Australia, and New Zealand.
- The enduring impact of this migration is evident in the global dominance of the Caucasoid race, along with Christianity and the Indo-European linguistic family.

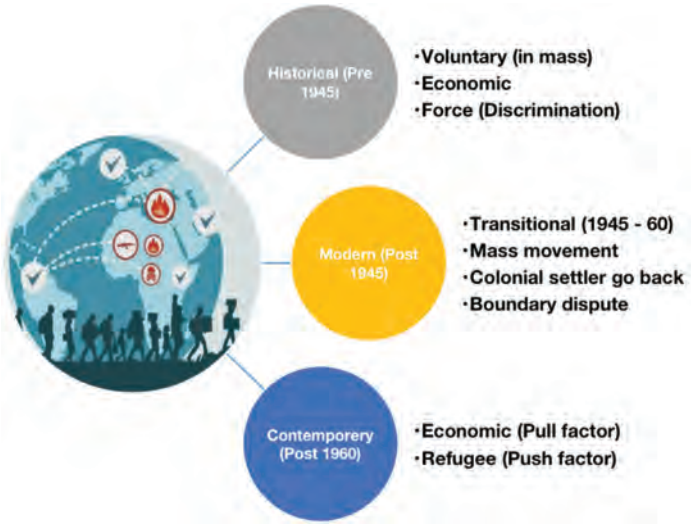


Fig. 5.39: International Migration

- Additionally, it facilitated the **economic advancement** of Anglo-America and Oceania by transferring both population and technology.
- Furthermore, this migration **facilitated the spread** of Christianity, European languages, scientific knowledge, and technology to various regions worldwide.
- **Incidences of global migration**:
  - Significant migration patterns became more noticeable following the 14th and 15th centuries, spurred by European advancements in voyages and sea routes, exemplified by figures like Columbus and Vasco-de-Gama.
  - European migrations to the Americas began, with two primary streams:
    - Migration from Britain to the Northeastern United States, now known as the New England region.
    - Migration from Spain and Portugal to South America and the Caribbean, resulting in Portuguese becoming the major language of Brazil.
  - The impact of European migration on indigenous populations in the Americas was severe, leading to the near eradication of civilizations like the Incas, Mayas (in Mexico), and Aztecs (in Mexico).
  - European settlers contributed to the mixed-race populations of South America, known as Mestizos, who have both European and indigenous ancestry.
  - In countries like Argentina and Chile, Mestizos constitute nearly 100% of the population.
  - **Migration after 1800:**
    - Following the opening of the Suez Canal in 1869, Europeans began migrating eastward and proceeded to establish colonies.

- ◊ New colonies were established in regions such as Australia, New Zealand, South Asia, and Southeast Asia.
- ◊ European settlers in Australia and New Zealand had a profound impact on the indigenous populations, leading to near extinction of native peoples such as the Bindibus in Australia and the Maoris in New Zealand.

Economic Migration

- This category encompasses the migration of both industrial and agricultural labourers.
- **Industrial labour migration** was driven by pull factors, particularly in Western European countries, spurred by the Industrial Revolution. Source regions for industrial labourers primarily include Southern Eastern Europe and Northern Africa. This migration significantly contributed to the cosmopolitan cultural identity of Western Europe.
- **Agricultural labour migration** primarily involved tropical equatorial islands with traditional plantation agriculture established by colonial settlers.
- Destination places for agricultural labour included:
  - Trinidad and Tobago
  - Cuba for cane plantation
  - Islands like Pemba, Mafia, and Zanzibar for spices such as cloves
  - Sri Lanka for tea and Malaysia for rubber
  - Fiji and Mauritius
- These islands attracted agricultural workers mainly from neighbouring mainland regions, influenced by a combination of push and pull factors.
- This migration resulted in diverse ethnic and cultural mixes in remote islands worldwide, with Indian culture diffusing to various parts of the globe.
- Following the abolition of the slave trade, a new system of labour employment called Indentured Labour emerged around 1800, leading to the migration of Asians to Africa, Southeast Asia, and North America under contract-based terms.
- Indians, particularly from Gujarat and Kutch, migrated to Eastern Africa (Uganda, Ethiopia, Tanzania, and South Africa), as well as to the Caribbean Islands.
- Chinese migration was primarily directed towards Southeast Asia and North America, with significant Chinese populations in cities like Vancouver, where they constitute 20% of the population, forming the largest ethnic minority group.
- These migrations have contributed to the formation of Asian diasporas across the world. For example, Indians make up over 50% of Fiji's population.

Forced migration

- From the 1600s to 1834, Europeans orchestrated the migration of Africans to South America and the Caribbean as part of the slave trade, which persisted until its abolition.
- The Negroid population, mainly from upper Guinea in West Africa, was treated as commodities, sold, and purchased, forcibly migrating primarily to Anglo-America, laying the groundwork for the emergence of the Black population, particularly in the USA.
- Slaves endured harsh working and living conditions, with tasks including clearing forests, levelling land, and contributing to the development of infrastructure.
- Interactions between Africans and other populations resulted in the creation of new mixed-race groups such as Mulattoes and Zamboes.
- Additionally, this era of migration contributed to global racial discrimination, particularly with Caucasoid regions exhibiting dominance.

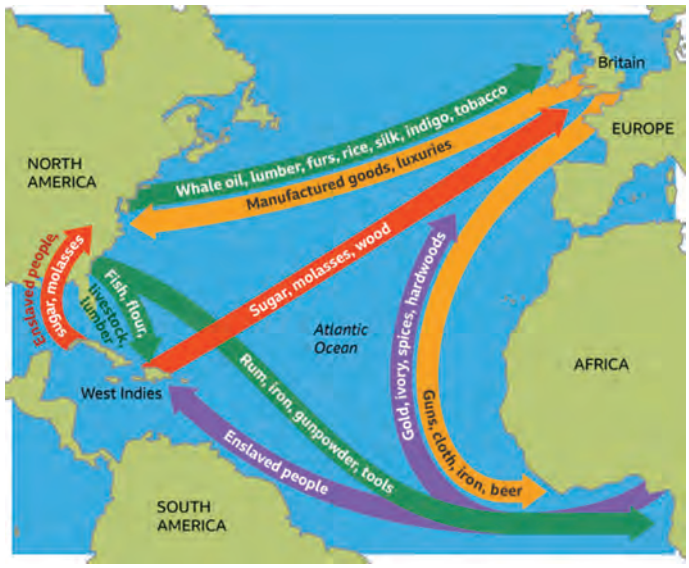


Fig. 5.40: Major Routes of Migration between Europe, Africa and America

Modern Migration

- Following the Second World War, the decline of colonial rule and the establishment of a more stable political map fostered modern migratory movements.
- Unlike historical migrations, modern movements covered longer distances and were characterised by more individualistic decision-making.
- Modern migration was:
  - Selective, involving specific groups such as colonial settlers or those affected by partition.
  - Temporal, as seen in the resettlement of Jews in Arab regions.
  - Highly globalised, with colonial settlers returning to their home countries from various parts of the world.
- Chronologically this phase is sub-classified as
  - **The transitional period of modern migration (1945-60):** This phase marks the establishment of a new

and evolving political landscape alongside significant population movements. Key aspects include:

- The decline of colonial settlement
- The partition of Indo-Pak resulted in one of the most violent migrations, with over 10 million people crossing borders within a few weeks.
- During and after World War II, a large number of Jews from Germany and the US migrated to West Asia following the creation of the state of Israel. This migration displaced local Arabs, who now reside as political refugees in other Arab nations, particularly in Jordan.
- Migration within Europe during and after the war occurred due to the gradual disintegration of the Ottoman Empire. Many North Africans and West Asians, such as Turks, migrated to Western Europe. Southern France has a significant Algerian population, while Germany and Switzerland have experienced an influx of Turkish migrants.

- **Migration post-1960:**
  - In the 1970s, there was a surge in construction activity in West Asia, attracting migrant workers who mostly lived as temporary residents in the region.
  - The contemporary phase, post-1960, was primarily driven by economic factors, with the developing world serving as the source area and the developed world as the destination.
  - Between 1970 and 1980, the economic mobilisation of crude oil played a key role in transforming West Asia into a significant destination.
    - This period saw the emergence of a fundamentalist Islamic cultural identity in the region, along with heightened geopolitical importance, leading to political uncertainty and sectarian violence.
  - Throughout the 1970s and continuing into the present, a major migrant group has been Asians moving towards Europe and the new world economies of the US, Canada, Australia, and New Zealand. Many of these migrants are professionals rather than labourers.
  - In the USA, the 1960s witnessed an influx of doctors, while in the 1990s, IT professionals and university lecturers became prominent migrant groups.
  - During this phase, migration within Africa was characterised by forced displacement due to factors such as drought, agricultural failure, and tribal conflicts, including conflicts in Anglo-Rwanda, Hulu-Tusti tribal disputes, and conflicts in Uganda, Ethiopia, and Sierra Leone, as well as between Sudan and South Sudan, resulting in the displacement of numerous Africans.
  - This period also saw **out-migration** from Central and West Asia due to conflicts such as the Iraq war, Afghan war, displacement after the disintegration of the USSR, displacement of Kurds, and migration of Hazaras from Afghanistan.
  - These migrants are classified as political refugees, or **"people of concern," according to HDI reports.**

IGNITE YOUR MIND

Modern Migration Marvels: Technology revolutionizes communication and transportation, impacting migration patterns like remote work (digital nomads) allows location independence. Are these changes a force for good or raising new concerns?

Refugee Movement

- **According to the UN Convention on Refugees**, approximately 90% of refugee movements across international borders involve illegal migration, with many refugees remaining in the host country. This situation poses challenges in terms of economic, demographic, and security factors.
- **Africa:**
  - Africa experiences the most frequent large-scale migrations, often triggered by recurring food shortages in the Sahel region, prompting people to migrate to neighbouring food-abundant countries like Nigeria.
  - Migration also occurs from countries affected by tribal conflicts, such as Uganda, Rwanda, and Burundi, with people moving to countries like Kenya and Tanzania.
  - The emergence of South Sudan, the youngest state on the global political map, has led to additional mass displacement of populations across international borders within the African continent.

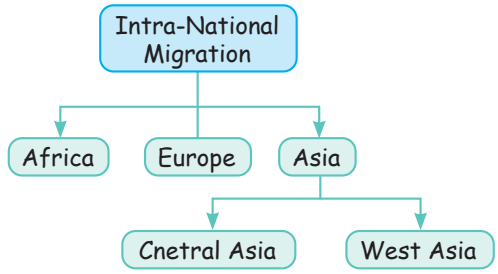


Fig. 5.41: Intra- National Migration

Trends of Migration In India

According to the 2011 census, India had 45.6 crore migrants (38% of the population). While the population expanded by 18% between 2001 and 2011, the number of migrants climbed by 45%. Internal migration accounted for 99% of overall migration, with immigrants (international migrants) accounting for 1%. There were 21 million rural-rural migrants,

accounting for 54% of all classifiable internal movements. Intra-state migration accounted for about 88% of all internal migration.

- The **greatest sources of interstate migrants** were Uttar Pradesh and Bihar, while the largest receiving states were Maharashtra and Delhi. **The majority of intra-state migration (70%) was motivated by marriage and family.**
- While the **population expanded** by 18% between 2001 and 2011, the number of migrants climbed by 45%. In 2011, domestic migration accounted for 99% of overall migration, with foreigners (international migrants) accounting for 1%.

Pattern of Migration Within India

There are **four trends observed in internal migration**: rural-rural, rural-urban, urban-rural, and urban-urban. According to the 2011 census, there were 21 crore rural-rural migrants, accounting for 54% of all classifiable internal migration. Rural-urban and urban-urban migration accounted for around 8 crore migrants each. There were around 3 million urban-rural migrants (7% of all classifiable internal migration).

- Migration can also be classified as **(i) intra-state and (ii) inter-state**. In 2011, intra-state migration accounted for over 88% of total internal mobility (39.6 crore persons). The largest source of migrants is the Hindi belt.
- According to the census, **four states accounted for 50% of total inter-state migrants in India**: Uttar Pradesh, Bihar, Rajasthan, and Madhya Pradesh. In terms of interstate migration flows, there is diversity among states. There were 5.4 crore inter-state migrants in 2011, according to the 2011 Census. According to the 2011 census, Uttar Pradesh and Bihar were the major source states of inter-state migration, while Maharashtra and Delhi were the largest receiving states.
- Around 83 lakh Uttar Pradesh citizens and 63 lakh Bihar inhabitants had relocated to other states, either temporarily or permanently. By 2011, around 60 lakh individuals from all over India had relocated to Maharashtra.

Pattern of External Migration

The **top destinations for Indian migrants** are the United Arab Emirates (UAE), the United States (US), Saudi Arabia, Oman, and Kuwait. These countries offer employment opportunities in a variety of sectors, such as construction, manufacturing, services, and healthcare.

- The **majority of Indian migrants are temporary labour migrants**. They migrate to work for a fixed period of time and then return to India. The majority of Indian migrants come from the states of Kerala, Tamil Nadu, Andhra Pradesh, Gujarat, Punjab, and Maharashtra. These states have a long history of migration and have well-established networks in destination countries.

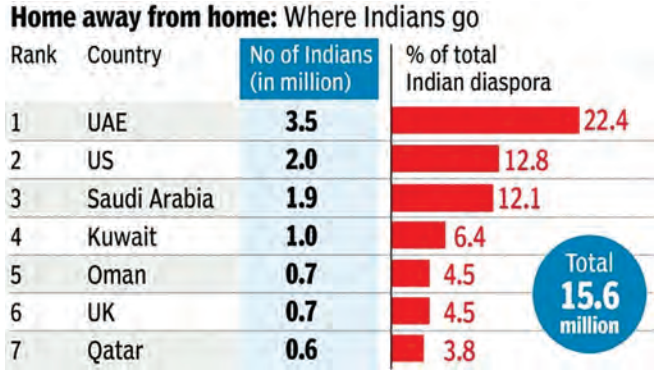


Fig. 5.42: Indian External Migrants

- **Indian Diaspora:** Millions of indentured labourers from Uttar Pradesh and Bihar were sent by the British to Mauritius, the Caribbean islands (Trinidad, Tobago, and Guyana), Fiji, and South Africa during the colonial period (British period).
  - The **Girmit Act (Indian Emigration Act)** covered all migrations. These indentured labourers had worse living circumstances than slaves. In recent years, a second generation of migrants has sought economic prospects in adjacent nations as professionals, craftsmen, traders, and industrial employees.
  - The **third wave of migrants included professionals** such as physicians, engineers, and software engineers, as well as management consultants, financial experts, and media professionals. They went to nations such as the USA, Canada, the UK, Australia, New Zealand, and Germany. These **individuals are among the most educated, highest-earning,** and prosperous populations. Education and knowledge-based emigration in the 1990s after liberalisation have made the Indian Diaspora one of the most powerful in the world.

Impacts of Migration

Positive Impacts

- **Transfer of Money:** Remittances sent by migrants are a significant benefit for the source region. Although internal migrants send fewer remittances than foreign migrants, they still significantly contribute to the economic prosperity of the originating area.
  - For **many impoverished areas** in Bihar, Uttar Pradesh, Orissa, Andhra Pradesh, and Himachal Pradesh, remittance is vital to their economy. In addition, unchecked migration to India's urban areas has led to congestion. Slum development in industrialised areas like Maharashtra, Gujarat, Karnataka, Tamil Nadu, and Delhi is a negative result of unregulated migration.
- **Population Redistribution**: Migration results in population redistribution within a country. One of the key reasons driving urban population expansion is rural-urban migration.

- **Wealth Redistribution:** Migration can help to reduce poverty and inequality. When people migrate from rural areas to urban areas, they often have access to better jobs and education opportunities. This can lead to an increase in their income and standard of living.
- **Supports Economy:** Migration can also help to boost the economy of the receiving country. Migrants often bring new skills and ideas with them, which can help to create jobs and businesses.
- **Agent of Social and Cultural Change:** Migrants transform society. New technology, family planning, and girl's education concepts spread from urban to rural regions through them. Migration causes the integration of disparate cultures. Positive contributions include the formation of composite cultures, breaking past limiting considerations and broadening the mental scope of society.

Negative Impacts

- **Demographic Imbalance:** Selective outmigration from rural areas due to age and ability negatively impacts the rural population structure. However, massive outmigration from Uttaranchal, Rajasthan, Madhya Pradesh, and Eastern Maharashtra has caused significant age and gender imbalances in these regions. Additionally, imbalances are also present in receiving states.
- **Strain on Infrastructure**: Overcrowding from rural-to-urban migration strains urban social and physical infrastructure. This led to uncontrolled urban settlement expansion and the creation of slums and shanty colonies. Additionally, over-exploitation of natural resources has led to the depletion of groundwater, air pollution, sewage disposal, and solid waste management issues in cities.
- **Loss of Human Resource:** Remittances are the primary advantage of migration for the source region, but the loss of trained human resources is the greatest cost. The worldwide market for advanced talents has grown, with vibrant industrial economies attracting and employing highly skilled workers from underprivileged countries. The current underdevelopment in the source region is reinforced.
- **Fuel Anti-Social Elements**: Anonymity among migrants and overcrowding can lead to social isolation and depression among individuals. Continued depression can lead to anti-social behaviours such as crime and drug misuse.

Do You Know?

- **Brain Drain**: It is the emigration of highly skilled or talented individuals from a particular country or region. This can have a negative impact on the sending country, as it loses valuable human capital.
- **Brain Gain:** This is the immigration of highly skilled or talented individuals into a particular country or region. This can have a positive impact on the receiving country, as it acquires new skills and expertise.
- **Brain Circulation**: It is the movement of skilled individuals in and out of a particular country or region. This can be beneficial for both the sending and receiving countries, as it facilitates the transfer of knowledge and skills.
- **Reverse Brain Drain**: It is the return of highly skilled individuals to their home country after emigrating. This can be a valuable source of knowledge and expertise for the sending country.
- **Brain Waste:** It is the underutilized or unemployment of highly skilled individuals. This can be a problem for both sending and receiving countries.

Issues Faced by Migrants

- **Lack of Access to Basic Services**: Many migrants, especially those from rural areas, face challenges in accessing basic services like healthcare, education, and sanitation in urban or industrial areas where they work. They often live in informal settlements with inadequate infrastructure.
- **Poor Working Conditions:** Migrant workers are often employed in low-paying jobs with poor working conditions. They may face exploitation, long working hours, and unsafe environments. The lack of job security can make them vulnerable to exploitation.
- **Social Exclusion:** Migrants often experience social exclusion in their destination areas. They may face discrimination and prejudice based on their regional or linguistic background. This can affect their overall well-being and integration into local communities. They often live in overcrowded and substandard accommodations, which can lead to health and sanitation issues.
- **Healthcare Access**: Migrants may have limited access to healthcare services, particularly in urban areas. This can lead to health disparities and difficulties in accessing treatment, especially during emergencies like the COVID-19 pandemic.
- **Exploitation by Middlemen:** Migrants, especially those in the informal sector, are sometimes exploited by middlemen or labour contractors who provide them with jobs but take a significant portion of their wages. Legal protections for migrant workers can be inadequate. They may not be aware of their rights or face challenges in accessing legal remedies in case of disputes.
- **Forced Displacement:** Some migrants are forced to migrate due to factors like natural disasters, conflict, or development projects. They may face displacement without proper compensation or rehabilitation.

IGNITE YOUR MIND

Climate Refugees: Rising sea levels and extreme weather are forcing mass migrations. Who will bear the responsibility for these climate-displaced populations? How can we protect vulnerable populations and build resilience?

International Organization For Migration (IOM) and World Migration Report

The International Organization for Migration (IOM) is the leading intergovernmental organisation in the field of migration. It was established in 1951 and is part of the United Nations system. IOM works to promote humane and orderly migration for the benefit of all. The organisation has 175 member states and offices in over 100 countries.

- The World Migration Report (WMR) is IOM's flagship publication. It is published every two years and provides a comprehensive overview of global migration trends. The WMR includes data, analysis, and expert commentary on a wide range of migration issues. The report is designed to inform policymakers, researchers, and the general public about the latest trends in migration.
- During 2021 and 2022, **India emerged as the leading contributor to migration** to OECD countries, **exceeding China** in this regard. India consistently occupied the top position, witnessing 0.41 million new migrants in both years, whereas China recorded 0.23 million new migrants. Romania followed closely with approximately 200,000 new migrants.

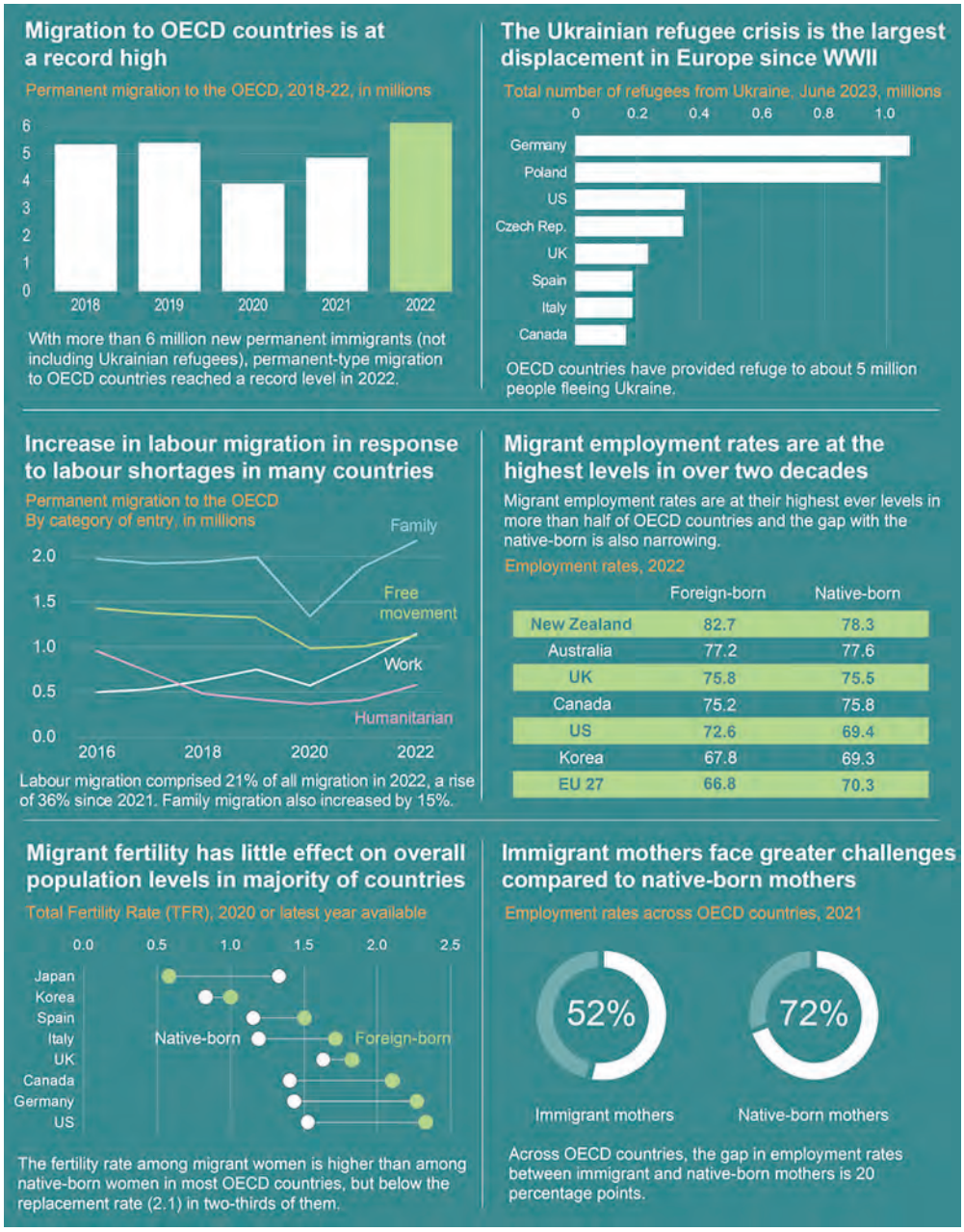


Fig. 5.43: OECD International Migration Outlook 2023 Report

- **Permanent-Type Migration by Main Categories:**
  - **Family Migration:**
    - In 2022, family migration retained its status as the predominant category for new permanent-type migrants, constituting 40% of all permanent-type migration.
    - This share has remained relatively stable over time, reflecting a consistent trend.
  - **Labour Migration:**
    - Over the years, the proportion of labour migration has shown a notable increase.
    - In 2022, labour migration accounted for 21% of permanent-type migration, compared to just 16% in 2019.
  - **Free Movement Migration:**
    - Conversely, the share of free movement migration, which includes movement within the

EU-EFTA and between Australia and New Zealand, has experienced a decline since 2020.

- In 2022, it comprised 21% of permanent-type migration, down from 28% in 2019, indicating a decreasing trend over the years.

Government Schemes for Migrant Population

- **Inter-State Migrant Workmen Act, 1979**: This act provides for the registration and regulation of inter-state migrant workers. It also provides for their protection against exploitation.
- **Building and Other Construction Workers Act, 1996**: This act provides for the social security and welfare of construction workers. It also provides for their safety and health.
- **Unorganized Workers' Social Security Act, 2008:** This act provides for the social security of unorganized workers, including migrant workers. It covers a variety of risks, such as death, disability, old age, and maternity.
- **Pradhan Mantri Awas Yojana-Urban (PMAY-U):** This scheme provides financial assistance to urban poor, including migrants, to build or buy houses. It also provides affordable housing rental complexes.
- **Deendayal Antyodaya Yojana-National Urban Livelihoods Mission (DAY-NULM)**: This scheme provides skill training and employment opportunities to urban poor, including migrants.
- **National Skill Development Mission (NSDM):** This mission aims to skill 300 million people by 2022. It provides skill training to migrants, including vocational training, apprenticeship training, and upgradation training.
- **National Health Mission (NHM)**: This mission provides access to quality healthcare services to all, including migrants. It provides free healthcare services at government hospitals and health centres.
- **National Migrant Information System (NMIS):** This is a web-based portal that provides information on migration-related services to migrants. It includes information on government schemes, job opportunities, and helpline numbers.

Draft National Migration Policy by NITI AAYOG

The NITI Aayog has drafted a national migration policy to address the challenges faced by migrant workers in India. The policy aims to create a framework for safe, orderly, and humane migration that promotes the development of migrants and their families.

The Policy has Five Key Pillars

1. **Recognition of Migration as a Fundamental Right:** The policy recognizes migration as a fundamental right and calls for the protection of the rights of migrants, including the right to freedom of movement, the right to work, the right to equal treatment, and the right to non-discrimination.
2. **Promotion of Safe and Orderly Migration:** The policy promotes safe and orderly migration through measures such as providing information and counselling to migrants, improving regularization procedures, and strengthening cooperation with countries of origin and destination.
3. **Protection of Migrants' Rights:** The policy establishes mechanisms to protect the rights of migrants, including access to justice, labour protection, and social security. It also addresses the specific needs of vulnerable groups of migrants, such as women, children, and victims of trafficking.
4. **Promotion of Migrant Integration**: The policy promotes the integration of migrants into society through measures such as access to education, healthcare, housing, and language training. It also encourages the social and cultural participation of migrants.
5. **Governance of Migration**: The policy establishes a clear framework for the governance of migration, with well-defined roles and responsibilities for different stakeholders. It also promotes transparency, accountability, and participation in migration policy-making.

The government of India has taken some steps to address the negative impacts of migration. For example, the government has implemented programs to provide education and healthcare to migrants, and it has also made efforts to improve the living conditions in slums and informal settlements. However, more needs to be done to address the challenges of migration in India.

CONCLUSION

The swelling global population presents significant challenges, impacting socioeconomic, environmental, and health domains adversely. Factors such as birth rate, mortality rate, and migration rates influence the escalating population growth rate of nations. This surge in population fuels increased demand for resources in densely populated regions, triggering deforestation for food production, urban congestion, and the proliferation of diseases.

Over the years, various government initiatives have been rolled out post-independence aimed at curbing population growth, achieving partial success. However, in certain regions witnessing rapid population expansion, there remains a pressing need for more targeted strategies to effectively address the issues.

Settlements and Urbanization

6

Human Settlement means a cluster of dwellings of any type or size where human beings live. For this purpose, people may erect houses and other structures and command some area or territory as their economic support-base. Thus, the process of settlement inherently involves grouping of people and apportioning of territory as their resource base.

According to the **United Nations Declaration on Human Settlements (1976),** "human settlements encompass the entire human community, be it a city, town, or village and includes all the elements, both social and material, that support and define this community, **including its organization, spiritual aspects, and cultural components."**. Settlements are places where people build their homes. In India, settlements vary in size and type, spanning from small hamlets to bustling metropolitan cities. **As the size of a settlement changes, so do its economic traits, social makeup, ecological features, and technological aspects.** Settlements can be either small and scattered or large and densely populated.

HISTORICAL EVOLUTION OF SETTLEMENTS

Global Drivers of Early Settlements

The **multifaceted drivers** of early settlements during this transformative period were intricately woven together by environmental, technological, and social factors, shaping the trajectory of human development.

Agricultural Revolution:

- The Agricultural Revolution, a pivotal period in human history, marked the **transition from nomadic, hunter-gatherer societies to settled agricultural communities.** This transformative shift, occurring **approximately 10,000 years ago**, laid the foundation for the development of complex civilizations.
- **Example:** Jericho in the Jordan valley, nestled near the Jordan river and fertile plains. This 9,000-year-old settlement thrived on agriculture, showcasing the shift from nomadic lifestyles to permanent communities around reliable water sources.

Environmental Influences: Early settlements weren't scattered randomly; they popped up in specific places due to environmental factors like:

- **Water:** Fresh water was (and still is) essential for drinking, cooking, and agriculture. Rivers, springs, and lakes naturally drew people in, leading to settlements along their banks.
- **Fertile Land:** Growing crops meant finding soil that could sustain them. Areas with rich soil and reliable rainfall became prime real estate for early farmers, paving the way for permanent settlements.
- **Shelter:** Protection from the elements and predators was paramount. Caves, mountainsides, and other natural formations offered early humans safe havens, often influencing where they settled.
- **Example:** Consider the **ancient Maya city of Tikal** in Guatemala, strategically positioned near a natural spring and limestone quarries. Access to these resources fueled its growth and development.

Trade and Commerce

- It provided a vital **economic foundation** for early settlements. By exchanging goods and services, communities could access **resources that were not available locally**.
- This enabled them to grow and prosper, and it also led to the development of specialized skills and professions.
- **Example:** Look at Carthage, strategically located on the Mediterranean coast, becoming a major trading hub due to its access to maritime routes and natural resources.

IGNITE YOUR MIND

Hidden Oasis or Forgotten Zone? Imagine discovering an isolated ancient settlement untouched by modern civilization. What questions would you ask, and what could it reveal about history and human adaptation?

Early settlements, like Jericho, Tikal, and Carthage, intricately wove together environmental, technological, and social factors, shaping the foundation of human civilization.

Evolution of Major Settlements in the World

Early human settlements, spanning from 10,000 BCE to 3,000 BCE, mark the **foundational stages of civilization.** During this period, **small nomadic communities** of hunter-gatherers established temporary habitats near water sources and abundant food, utilizing rudimentary shelters crafted from **natural materials**. Notable examples include Çatalhöyük in Turkey, Jericho in Palestine, and Mehrgarh in Pakistan.

Early Settlements (10,000 BCE - 3,000 BCE)

- Marked by **small nomadic communities and rudimentary shelters**, this era witnessed the dawn of human settlement patterns, shaping the course of history.

- **Characteristics:**
  - Small, nomadic communities of hunter-gatherers.
  - Temporary settlements near water sources and food availability.
  - Rudimentary shelters made from natural materials.
  - **Examples:** Çatalhöyük (Turkey), Jericho (Palestine), Mehrgarh (Pakistan).

The Rise of Agriculture and Urbanization (3,000 BCE - 500 BCE)

- A transformative shift occurred with the **rise of agriculture,** propelling humanity into an era of permanent settlements and burgeoning urban centers.
- **Characteristics:**
  - Agricultural revolution leads to permanent settlements and population growth.
  - Development of urban centers with specialized functions (trade, administration, religion).
  - Monumental architecture and complex social structures emerge.
  - **Examples:** Mesopotamia (Sumer, Babylon), Indus Valley Civilization (Mohenjo-Daro, Harappa), Ancient Egypt (Memphis, Thebes).

Classical Civilizations and Empires (500 BCE - 500 CE)

During this period the world witnessed the flourishing of classical civilizations and the emergence of mighty empires, showcasing advanced infrastructure, artistic achievements, and intricate social systems that left an indelible mark on history. **Examples:** Athenian Democracy, Roman Empire, Han Dynasty (China).

Medieval Period and Feudalism (500 CE - 1500 CE)

- During the medieval period ushered in the **decline of centralized empires**, giving rise to feudal societies characterized by walled cities and flourishing trade routes.
- **Characteristics:**
  - Decline of centralized empires and rise of feudal societies.
  - Walled cities for protection, with surrounding agricultural lands worked by peasants.
  - Growth of trade and commerce along established routes like the Silk Road.
  - **Examples:** Medieval European towns, Islamic cities like Baghdad and Cordoba, Angkor Wat (Cambodia) etc.

The Renaissance and Early Modern Era (1500 CE - 1800 CE)

- The Renaissance and Early Modern Era witnessed a profound revival of classical learning, inspiring urban planning innovations and fostering cultural rebirth.
- **Characteristics:**
  - Renewed focus on classical learning and urban planning.
  - Rise of maritime trade and colonial empires.
  - Development of centralized governments and standing armies.
  - **Examples:** Renaissance cities like Florence and Venice, London, Amsterdam etc.

Urban Settlements During 18th and 19th Century

- **Industrial Revolution:** Rapid urbanization in Europe and North America due to industrial growth and migration.
  Examples:
  - London, Manchester, Birmingham (UK)
  - New York, Chicago, Pittsburgh (US)
- **Colonial cities:** Growth of port cities and administrative centers in colonies.
  Examples:
  - Calcutta, Bombay (India)
  - Rio de Janeiro, Buenos Aires (Latin America)
- **Characteristics:**
  - **Purpose**: Industrial production, trade, administrative centers.
  - **Layout:** Densely packed, often with distinct industrial and residential districts, poor sanitation and overcrowding in early stages.
  - **Architecture:** Factories, warehouses, tenements, later public buildings and grand avenues reflecting civic pride.
  - **Social Structure**: Diverse, with working class, middle class, and wealthy elites, social tensions and labor movements.
  - **Economy:** Industry, trade, finance, services, rapid economic growth and innovation alongside social problems.

Settlements in the 21st Century

The 21st century has witnessed a **dynamic evolution of settlements** across the globe, shaped by diverse factors like urbanization, globalization, technological advancements, and environmental concerns.

- **Mega-cities:** The number of megacities with over 10 million inhabitants continues to grow, concentrating large populations and economic activity.
  - **Examples:** Tokyo, Japan (37.4 million), Delhi, India (20.8 million), Shanghai, China (27.8 million)
- **International migration:** Increased flows of people across borders impact both sending and receiving communities, shaping settlement patterns and cultural dynamics.
  - **Examples**: Dubai, UAE (around 85% of residents are foreign-born), Toronto, Canada (almost 52% of residents are foreign-born), New York City, USA (around 37% of residents are foreign-born).
- **Transnational communities:** Individuals maintain connections across geographic boundaries, influencing cultural exchange and settlement development.

- **Examples:** Active diaspora playing a role in cultural exchange and supporting development back home(Silicon Valley, Bangalore).

- **Refugee settlements:** Growing numbers of refugees and internally displaced persons pose challenges and opportunities for integration and support.
  - **Examples**: Zaatari camp in Jordan (Syrian refugees), Dadaab camp in Kenya (Somali refugees), Kutupalong camp in Bangladesh (Rohingya refugees).
- **Remote work and digital nomadism:** Technology enables more flexible work arrangements, potentially impacting residential choices and settlement patterns.
  - **Examples:** Chiang Mai, Thailand (popular hub for digital nomads), Lisbon, Portugal (attracts remote workers with affordable living and good infrastructure), Tallinn, Estonia (e-residency program for digital entrepreneurs).

The evolution of major settlements reflects the ever-evolving human story. It's a testament to our ingenuity and adaptability, but also a reminder of the challenges we face in managing our urban environments and ensuring sustainable growth for future generations.

Evolution of Settlements In India

India's rich tapestry of settlements boasts a unique history shaped by diverse geographical features and cultural influences. They are as follows:

- **Indus valley civilization (2600-1900 BCE):** The meticulously planned cities of Mohenjo-daro and Harappa, with advanced drainage systems and grid-like layouts, exemplified sophisticated urban planning and social organization.
- **Vedic period (1500-500 BCE):** Iron age settlements like Hastinapur along the Ganges river emerged, marking the development of janapadas, small kingdoms, and agricultural communities.
- **Maurya empire (322-185 BCE):** Emperor Ashoka's reign saw the development of Pataliputra, a planned city featuring grand palaces, canals, and administrative buildings, reflecting the empire's power and efficiency.
- **Medieval era:** the rise of kingdoms like the Cholas in south India led to the development of fortified cities like Madurai, known for its magnificent temples and busy trade centers.
- **Modern urbanization in India:** India's recent rapid urbanization is driven by factors like:
  - **Economic growth:** Bangalore's transformation into an IT hub, aptly nicknamed "Silicon valley of India," showcases the economic opportunities driving urban growth.
  - **Improved infrastructure:** Delhi's extensive metro system exemplifies investments in transportation infrastructure, making cities more accessible and attractive.
  - **Rural-urban migration:** Increased mechanization in agriculture, as seen in Punjab's green revolution, has pushed many towards cities seeking better livelihoods.

India's unique history mirrors this global phenomenon, showcasing **diverse cityscapes shaped by empires, trade, and modern forces**. While rapid urbanization presents challenges, sustainable planning holds the key to thriving, livable cities for future generations.

CLASSIFICATION OF SETTLEMENTS

Settlements **vary in size and type**. They range from a hamlet to metropolitan cities. With size, the economic character and social structure of settlements changes and so do its ecology and technology. Settlements could be small and sparsely spaced; they may also be large and closely spaced.

The sparsely located small settlements are called **villages,** specializing in agriculture or other primary activities. On the other hand, there are fewer but larger settlements which are termed as urban settlements specialising in **secondary and tertiary activities.**

Across the globe, humans have established **settlements in diverse forms**, reflecting their needs, resources, and lifestyles. There are two broad categories of settlements as permanent and temporary.

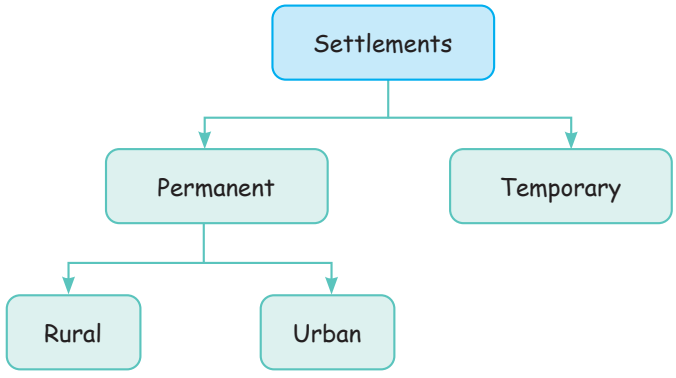


Fig. 6.1: Settlements

Temporary Settlements

These are dwellings **established for a limited period**, often in response to **specific needs or environmental factors**. They're characterized by:

- **Mobile or impermanent structures:** Tents, huts, or temporary shelters made from readily available materials provide basic accommodation for the duration of the stay.
- **Limited infrastructure:** Basic sanitation facilities and minimal amenities cater to the immediate needs of the inhabitants.
- **Simple social structures**: Temporary communities often have informal leadership and rely on communal living arrangements.

- **Specific purposes:** These settlements may be established for seasonal work, resource extraction, disaster relief, or cultural gatherings.

Global Examples

- **Nomad camps:** Communities like the Bedouins in the Middle East or the Maasai in Africa practice nomadic lifestyles, setting up temporary camps for grazing livestock and adapting to seasonal changes.
- **Mining towns:** Settlements like gold mining towns in Alaska or diamond mining towns in South Africa are established to support resource extraction and typically exist only for the duration of the mining activity.
- **Refugee camps:** Temporary shelters are established to provide basic necessities for people displaced by conflict or natural disasters.

Indian Examples

- **Kumbh Mela:** This massive Hindu pilgrimage attracts millions of visitors for a few weeks, necessitating the creation of a temporary city with tents, food stalls, and sanitation facilities.
- **Tribal settlements**: Some Indian tribes, like the Jarawa in the Andaman Islands, have traditionally lived in semi-nomadic settlements, building temporary huts from readily available materials.

Permanent Settlements

These are **long-lasting communities built** to endure for generations. They're typically characterized by:

- **Durable housing:** Permanent structures made from materials like brick, wood, or concrete provide long-term shelter and withstand harsh weather conditions.
- **Developed infrastructure:** A network of roads, sanitation systems, and public utilities like electricity and water caters to the needs of a growing population.
- **Complex social structures:** Permanent settlements often have established governance systems, educational institutions, and healthcare facilities to support a thriving community.
- **Economic activity:** Agriculture, trade, and various industries provide livelihoods for residents and contribute to the settlement's growth.

Global Examples

- **Major cities:** London, Tokyo, New York City, and Mumbai are prime examples of permanent settlements that have evolved over centuries, boasting robust infrastructure, diverse populations, and thriving economies.
- **Agricultural villages:** Rural communities in regions like the Nile Delta in Egypt or the Punjab in India have sustained themselves through agriculture for millennia, building permanent settlements with homes, irrigation systems, and community centers.

Indian Examples

- **Harappa and Mohenjo-daro:** These ancient Indus Valley Civilization cities, dating back to 2600 BCE, showcase sophisticated urban planning, grid-patterned streets, and permanent brick structures, illustrating the enduring nature of early settlements in India.
- **Hill stations:** Shimla, Munnar, and Darjeeling were established by the British as permanent hill retreats, featuring colonial-era architecture and infrastructure that continue to attract tourists and residents today.

Based on economic activities, Permanent settlements can be divided into two general categories:

1. Rural settlements.
2. Urban settlements.

Difference Between Urban and Rural Settlements

Types of Settlement and their Comparison		
Aspect	**Rural settlements**	**Urban settlements**
Definition	A settlement with low population density, dispersed or clustered patterns, and primary economic activities based on land and natural resources.	A settlement with high population density, compact built-up areas, and diverse economic activities focused on industries, services, and trade.
Main economic activities	Agriculture, livestock, dairy farming, forestry, fisheries, mining.	Non-agricultural activities, industries, services.
Community characteristics	Strong community bonds.	Heterogeneous, diverse, and disparate.
Residence origin	Predominantly country-bred residents.	Include a smaller proportion of country-bred residents.
Economic dependence	Land-based primary economic activities.	Processing raw materials, manufacturing, and services.
Role in regional economy	Provide food and raw materials to urban areas.	Act as nodes of economic growth, serving rural hinterlands.
Social relationships	Intimate and less mobile social relations.	Complex, fast-paced life with more formal social relations.

RURAL SETTLEMENTS

Rural settlements serve as the **fundamental units** of human habitation in non-urban regions, encompassing a **diverse range of communities and housing arrangements**.

The study of rural settlements is indispensable, as it enables a deeper grasp of **rural life dynamics** and facilitates the resolution of crucial matters, **including** agricultural techniques, resource administration, community growth, and the promotion of sustainable lifestyles.

Types of Rural Settlements

Rural settlement types are defined by the size of the built-up area and the distance between houses. **Different factors and conditions contribute** to these varied settlement types **including physical characteristics** like terrain, altitude, climate, and water availability; cultural and ethnic factors such as social structure, caste, and religion, and security considerations like defence against theft and robberies.

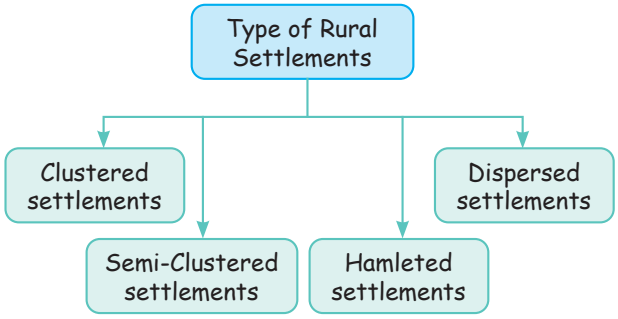


Fig. 6.2: Types of Rural Settlements

The types of rural settlement are classified as follows:

Clustered Settlements:

Clustered settlements, also known as **nucleated villages,** are a charming and ubiquitous type of rural community found across the globe. In these settlements, houses huddle together in close proximity, fostering a **strong sense of community** and **shared space**. Here rural settlement patterns range from compact to linear, to circular, and grid.

Fig. 6.3: Clustered Settlement

Key Features

- **Compact layout:** Houses are tightly packed together, often around a central focal point like a church, square, well, or market. This creates a sense of enclosure and intimacy.
- **Shared spaces:** Common areas like village greens, plazas, or courtyards provide opportunities for social interaction, gatherings, and community events.
- **Efficient resource utilization:** Shared infrastructure like water sources, sanitation facilities, and community centers minimize resource usage and promote sustainability.
- **Strong social bonds:** Close proximity fosters a strong sense of community, with residents readily offering help and support to one another.
- **Cultural vibrancy:** Shared traditions, festivals, and rituals thrive in the close-knit atmosphere, contributing to a rich cultural heritage.

Global Examples of Clustered Settlements

- **European villages:** Quaint villages dotting the countryside of countries like France, Italy, and Germany are classic examples of clustered settlements.
- **Japanese fishing villages:** Tightly packed houses around harbors are a common sight in Japanese fishing communities, fostering cooperation and social cohesion.

Indian examples of clustered settlements

- **Villages of the Indo-Gangetic Plain:** The fertile plains of north India are home to numerous clustered villages, characterized by mudbrick houses and vibrant communal spaces.
- **Tribal settlements of northeast India:** Many tribal communities in the northeast, like the Apatani and Ao Nagas, live in compact villages with distinctive architectural styles.

Semi-Clustered Settlements

Semi-clustered settlements, also known as **fragmented settlements**, occupy an intriguing middle ground between the **tightly-knit world of nucleated villages and the scattered independence of dispersed settlements**. They offer a fascinating glimpse into the diverse ways humans organize their rural communities, striking a balance between social interaction and individual space.

Key features

- **Hybrid layout:** Houses are grouped in smaller clusters or hamlets, often scattered across a larger area, with some degree of separation between them.

Fig. 6.4: Semi-Clustered Settlements

- **Gradual transition:** The density of houses gradually decreases as you move away from the central cluster, creating a sense of transition from the village core to the surrounding agricultural lands.
- **Multiple nuclei:** Sometimes, semi-clustered settlements may have several smaller clusters or hamlets, reflecting kinship groups, social divisions, or historical factors.
- **Adaptability to terrain:** This layout can be advantageous in terrains with uneven topography or limited resources, allowing communities to optimize land use and access.
- **Evolutionary dynamics:** Semi-clustered settlements can arise from the fragmentation of larger villages due to various factors like population growth, resource scarcity, or social conflicts.

Fig. 6.5: Semi-Clustered Settlements

Global examples of semi-clustered settlements

- **Scottish crofting settlements:** Houses cluster around small patches of arable land in the rugged Scottish highlands, reflecting the challenges of farming in this environment.
- **Indonesian Kanpungs:** Traditional Kanpungs in Indonesia often feature clusters of houses surrounded by rice paddies, showcasing the close relationship between community life and agriculture.

Indian examples of semi-clustered settlements

- **Tribal villages of northeast India:** Many tribal communities in the northeast, like the Garo and Khasi tribes, live in semi-clustered settlements, with family houses grouped together within larger village boundaries.
- **Villages of the Deccan plateau:** In the deccan plateau regions of India, like Maharashtra and Karnataka, some villages exhibit a semi-clustered pattern, with hamlets scattered around central water sources or market areas.

Hamleted Settlements

Hamleted settlements, also known as **Panna settlements,** paint a charming picture of rural life scattered across the landscape. Unlike the tightly knit nucleated villages or the vast stretches of dispersed settlements, hamlets offer a **unique blend of community and independence.**

Key Features

- **Fragmented clusters:** Houses are grouped in small, distinct hamlets or "tolas" scattered across a larger area, often separated by agricultural fields, pastures, or natural features.

Fig. 6.6: Hamleted Settlement

- **Shared identity:** Despite the physical separation, the hamlets share a common identity and often belong to a single larger village administrative unit.
- **Social bonds within hamlets:** Strong social bonds and close-knit communities flourish within each hamlet, fostered by proximity and shared traditions.
- **Resource dependence:** Each hamlet might have its own resources like wells, ponds, or communal grazing lands, promoting self-sufficiency and localized resource management.
- **Historical and social factors:** The formation of hamlets can be influenced by historical factors like kinship groups, social divisions, or land ownership patterns.

Global examples of hamleted settlements:

- **Scottish Crofting settlements:** Similar to semi-clustered settlements, Scottish Crofting communities often exhibit a hamleted pattern, with families residing in small clusters scattered across the rugged landscape.
- **Indonesian Kampungs:** Some Kampungs in Indonesia, particularly in mountainous regions, showcase a hamleted layout, with houses grouped around shared resources like springs or communal gardens.
- **Amazonian indigenous villages:** Several indigenous communities in the Amazon rainforest adopt a hamleted lifestyle, with families residing in small clusters connected by trails and sharing central communal areas.

Indian examples of hamleted settlements:

- **Hamleted Settlement of West Bengal:** These distinct hamlets are a characteristic feature of rural West Bengal, often housing extended families or specific caste groups within a larger village boundary.
- **Tribal villages of northeast India:** Many tribal communities in the northeast, like the Naga tribes, traditionally live in hamlets scattered across hilly slopes, reflecting their agricultural practices and social structures.
- **Hamlets of the Nilgiri hills:** The picturesque Nilgiri hills in south India are dotted with hamlets inhabited by indigenous communities and tea estate workers, showcasing a unique blend of cultures and land use patterns.

Dispersed Settlements:

Dispersed settlements, where **individual houses or homesteads stand apart,** paint a contrasting picture to the close-knit communities. These scattered dwellings offer a lifestyle **deeply connected with nature** and often fueled by independent pursuits.

Key Features

- **Independent dwellings:** Houses are isolated from each other, standing alone amidst agricultural lands, pastures, or natural landscapes.
- **Self-sufficiency:** Residents rely heavily on their own resources and skills for farming, animal husbandry, or other income-generating activities.
- **Limited shared infrastructure:** Public services and amenities might be scarce or absent, requiring residents to be resourceful and independent.

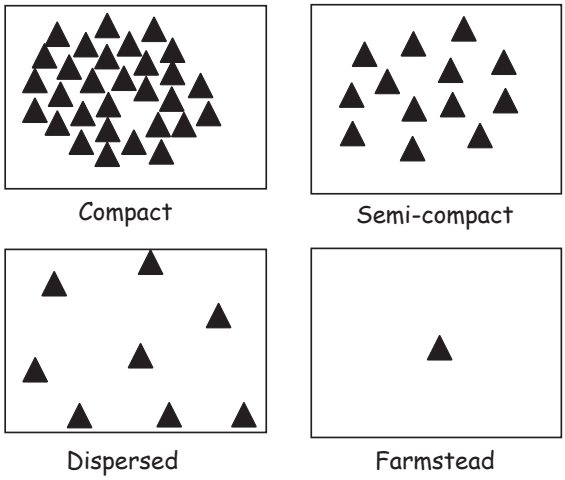


Fig. 6.7: Dispersed Settlements

- **Strong connection to nature:** Dispersed settlements foster a deep connection with the surrounding environment, shaping daily life and routines.
- **Unique social dynamics:** Social interactions often occur within families or through occasional gatherings, creating a distinct social fabric compared to closely knit communities.

Global examples of dispersed settlements

- **American ranches:** Vast stretches of land in the American west are dotted with isolated ranches, where families raise livestock and manage extensive agricultural operations.
- **Scandinavian farmlands:** In countries like Sweden and Norway, individual farmsteads stand amidst idyllic landscapes, reflecting a long tradition of independent farming practices.
- **Mongolian nomadic settlements:** The nomadic communities of Mongolia live in transportable dwellings called gers, moving across vast grasslands following seasonal patterns for grazing their livestock.

Indian examples of dispersed settlements

- **Tribal villages in hilly regions:** The Himalayan foothills and tribal belts of central India often feature dispersed settlements, shaped by the challenging terrain and reliance on shifting cultivation or hunting-gathering practices.
- **Desert settlements in Rajasthan:** The Thar desert in Rajasthan is home to scattered villages and nomadic communities adapting to the harsh arid environment through unique livelihood strategies.
- **Forest settlements in northeast India:** Some indigenous communities in the northeast, like the Apatani tribe, traditionally live in dispersed settlements within dense forests, practicing sustainable resource management and maintaining a close connection to nature.

IGNITE YOUR MIND

Scattered Farms or Clustered Houses: Why do rural settlements have different patterns? Explore the impact of geography, resources, and social factors.

PATTERNS OF RURAL SETTLEMENTS

Rural settlement patterns refer to the **spatial arrangement of houses** in relation to one another within a village. These **patterns are influenced by** the village's location and the surrounding topography.

Additionally, **socioeconomic and cultural factors** play a role in shaping the diverse forms of rural settlements. These distinct patterns can be observed in the rural landscapes across the country.

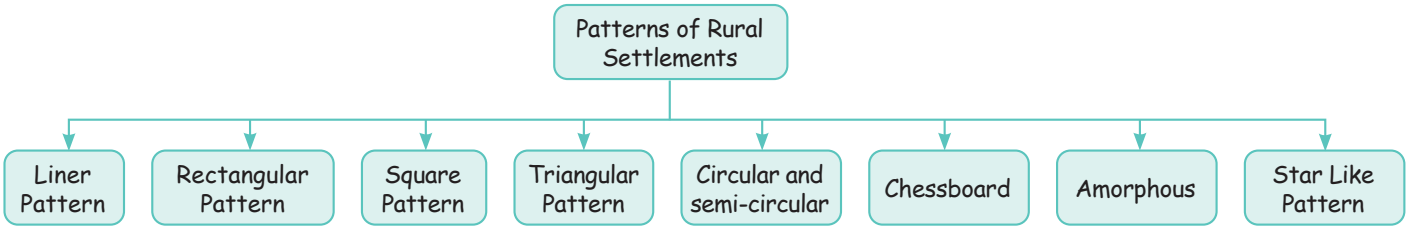


Fig. 6.8: Patterns of Rural Settlements

Some of these patterns are:

Linear Settlements

A linear settlement is a type of human settlement characterized by its **elongated shape**, where buildings and structures are **arranged along a line**, typically following a road, river, canal, coastline, or mountain range.

Characteristics

Elongated Form: The most defining feature is their elongated shape, often resembling a ribbon stretched across the landscape. This linear layout contrasts with the more radial or clustered forms of other settlement types.

- **Single Main Artery:** A central road, railway, river, or canal serves as the backbone of the settlement, providing access to homes, businesses, and other facilities. This main artery also acts as a social hub and focal point for community life.
- **Limited Lateral Growth:** Due to their linear form, expansion typically occurs along the main artery rather than outwards in all directions. This can create limitations on space and infrastructure development.
- **Lack of Central Core:** Unlike many traditional settlements with a central plaza or square, linear settlements often lack a distinct center. Their focus is instead distributed along the main artery.

Fig. 6.9: Linear settlement

Global Examples

- **English villages along rivers:** Quaint villages like Bourton-on-the-Water and Bibury in England showcase linear settlements following the course of rivers.
- **Dutch settlements on canals:** Traditional Dutch villages like Giethoorn and Marken were built along canals, utilizing them for transportation and water access.

Indian Examples

- **Villages along the Ganges and Brahmaputra rivers:** Numerous villages in India, particularly in the fertile Gangetic plain, trace their layouts along the banks of these mighty rivers, relying on them for water and transportation.
- **Settlements along highways and railway lines:** The development of national highways and railway lines has led to the emergence of linear settlements in various parts of India, particularly in areas with previously scattered populations.

Double Linear Settlements

The term "double linear settlements" typically refers to a specific pattern of human habitation where **two linear arrangements of structures**, such as buildings or houses, exist in close proximity, **forming parallel lines.** This settlement pattern often **occurs along natural features** like rivers, roads, or topographical features, resulting in two distinct lines of development.

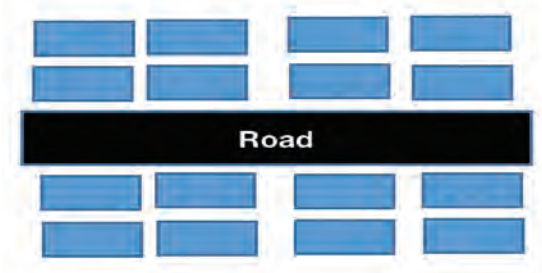


Fig. 6.10: Double Linear Settlement

Characteristics

- **Dual Arteries:** Unlike their single-artery counterparts, double linear settlements boast two main roads or axes that act as the primary organizing elements. These arteries can be parallel, slightly offset, or even converge at a central point, influencing the overall form of the settlement.
- **Enhanced Connectivity:** The presence of two main arteries and connecting cross-axes fosters greater internal connectivity and accessibility compared to single linear settlements. This allows for better traffic flow, easier movement within the community, and potential for more diversified development.
- **Distinct Sub-Districts:** The dual-artery structure often leads to the formation of distinct sub-districts or neighborhoods within the settlement. These districts can develop their own identities and characteristics based on their location, function, or historical development.
- **Varied Urban Fabric:** The grid-like layout allows for a more diverse and nuanced urban fabric compared to a single linear form. This flexibility can accommodate a wider range of building types, green spaces, and public amenities, creating a more dynamic and visually appealing environment.

Global Examples

- **Bridge and ferry settlements:** Villages often develop on both sides of bridges or ferry crossings, utilizing the central infrastructure for connection and access.
- **Island settlements with central canals:** Some island communities, like Venice in Italy, feature double linear settlements along central canals, forming the backbone of the town's transportation and development.

Indian Examples

- **Villages along canals in Kerala:** The intricate network of canals in Kerala, known as backwaters, has fostered

the development of double linear settlements, with houses lining both sides and relying on the canals for transportation and resource access.

- **Island settlements in Lakshadweep:** The coral islands of Lakshadweep feature villages with houses lining up on both sides of narrow lagoons, creating a unique double linear pattern adapted to the limited land space.

Rectangular Patterns

Rectangular patterns, characterized by **neatly organized houses arranged in grid-like formations**, stand out amidst the diverse tapestry of rural settlements worldwide. These **orderly arrangements** offer a glimpse into communities shaped by factors like flat landscapes, efficient resource utilization, and historical influences.

Characteristics

- **Grid-like layout:** Houses are positioned in straight lines, forming streets that intersect at right angles, creating a rectangular grid.
- **Flat terrain:** Rectangular patterns typically flourish on flat, fertile plains or wide intermontane valleys, where the even topography facilitates the establishment of straight roads and organized development.

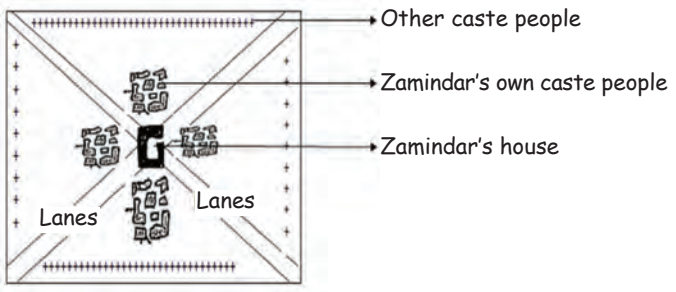


Fig. 6.11: Rectangular Pattern

- **Efficient land use:** The grid layout minimizes wasted space and allows for efficient utilization of land for both housing and agricultural activities.
- **Shared infrastructure:** Streets, water channels, and other infrastructure can be easily planned and implemented within the grid system, promoting resource sharing and accessibility.
- **Sense of order and community:** The orderly arrangement can foster a sense of community and shared identity among residents, while also facilitating navigation and communication within the settlement.

Global Examples

- **German villages:** Traditional German villages like Rothenburg ob der Tauber and Dinkelsbühl showcase orderly rectangular layouts, often centered around a communal square or church.
- **Chinese farming communities:** Many villages in China's fertile plains, like Pingyao and Zhouzhuang, feature rectangular patterns with houses arranged in grid-like formations, reflecting a long history of planned agrarian settlements.

Indian Examples

- **Villages in the Indo-Gangetic Plain:** The fertile plains of North India, particularly in states like Punjab and Haryana, are home to numerous villages with distinct rectangular layouts, reflecting the influence of land surveys and planned agricultural development during the British era.
- **Planned towns and cities:** Several planned towns and cities in India, such as Chandigarh and Gandhinagar, were established with rectangular layouts, aiming for efficient resource management and infrastructure development.
- **Traditional settlements in South India:** Some temple towns in South India, like Madurai and Tanjore, showcase rectangular patterns radiating outwards from the central temple complex, reflecting historical planning and religious significance.

Square Pattern

While rectangular patterns dominate the landscape of organized rural settlements, square patterns offer a fascinating variation on the theme. These communities, characterized by **houses arranged in a neat square or grid formation,** present a unique blend of order, resource efficiency, and cultural influences.

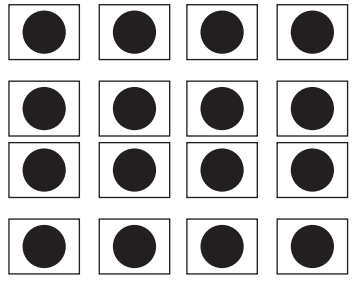


Fig. 6.12: Square Pattern

Characteristics

- **Quadrilateral layout:** Houses are positioned along streets that form a perfect square or a grid with square blocks, creating a distinct geometric outline.
- **Modified rectangles:** Square patterns often originate from rectangular layouts, with additional streets or boundaries enclosing the existing grid to form a square shape.
- **Symbolic or defensive purposes:** The deliberate creation of a square might be driven by symbolic significance, religious beliefs, or even defensive considerations in historical contexts.
- **Efficient land use:** Similar to rectangles, square layouts minimize wasted space and allow for efficient utilization of land for housing and other activities.
- **Strong sense of community:** The enclosed nature of the square layout can foster a strong sense of community and shared identity among residents, creating a distinct social atmosphere.

Global Examples

- **New Harmony, Indiana:** This utopian community in the United States was designed with a central square surrounded by gridded streets, reflecting the ideals of social harmony and equality.
- **Zuoz, Switzerland:** This picturesque village in the Swiss Alps showcases a unique square layout, with houses arranged around a central church and village square.

Indian Examples

- **Villages in Rajasthan and Gujarat:** Some villages in these arid regions, particularly those with fortified history, exhibit square or near-square layouts, often centered around a water source or communal space.
- **Historical towns and cities:** Some historical towns and cities in India, like Jaisalmer in Rajasthan, present a mix of rectangular and square patterns, reflecting different phases of development and influences.

Triangular Pattern

Triangular settlements, with their distinct geometric charm, stand out amidst the more common rectangular and square layouts in rural communities. These communities, where **houses arrange themselves around the points of a triangle**, offer a unique glimpse into the interplay of geographical constraints, resource utilization, and historical influences.

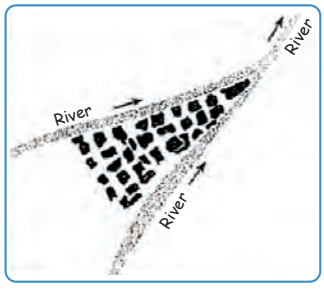


Fig. 6.13: Triangular Settlement

Characteristics

- **Triangular outline:** Houses are positioned along three converging streets, forming a distinct triangular shape on the map.
- **Natural boundaries:** Often, the edges of the triangle are defined by natural features like rivers, coastlines, or mountain ridges, limiting expansion in certain directions.
- **Efficient land use:** Within the triangular space, houses can be arranged compactly, minimizing wasted land and potentially maximizing agricultural space outside the settlement.
- **Central gathering areas:** The convergence of the three streets at the center can create a natural communal space, fostering social interaction and shared activities.
- **Symbolic or defensive significance:** In some cases, the triangular layout might hold symbolic meaning within the community or even offer strategic advantages for defense in historical contexts.

Global Examples

- **Fishing villages in Vietnam:** Some Vietnamese fishing villages along the Mekong Delta, like Cai Be and My Tho, exhibit triangular patterns shaped by the convergence of rivers and canals.
- **Medieval towns in Europe:** Certain European towns, like Mont Saint-Michel in France and Visby in Sweden, developed within fortified triangular walls, adapting to their defensive needs.

Indian Examples

- **Villages in the Himalayan foothills:** Several villages in the Himalayan regions, particularly those nestled between mountains or along river confluences, adopt triangular layouts to adapt to the challenging terrain.
- **Tribal settlements in Northeast India:** Some tribal communities in Northeast India, like the Naga tribes, might have settlements with triangular outlines influenced by specific cultural practices or land ownership patterns.
- **Historical towns and forts:** Certain historical towns and forts in India, like Jaisalmer Fort in Rajasthan, incorporate triangular elements within their overall layout, reflecting strategic considerations or symbolic meanings.

Circular And Semi-CircularPattern

Circular and semicircular settlements, with their **distinctive curved layouts**, offer a unique twist on the more common geometric patterns found in rural communities. These settlements, where houses huddle along the **arc of a circle or half-circle**, present a fascinating glimpse into the interplay of geography, resource utilization, and cultural influences.

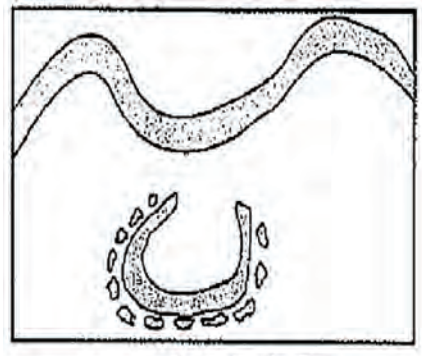


Fig. 6.14: Semi-Circular Pattern

Characteristics

- **Curved layout:** Houses are positioned along a curved road or path, forming a distinct circular or semi-circular shape on the map.
- **Central focus point:** Often, the layout centers around a shared space like a well, a square, a church, or a communal area.
- **Efficient land use:** The compact, inward-facing arrangement can minimize wasted space and potentially maximize agricultural land outside the settlement's curve.

- **Strong sense of community**: The close proximity of houses and the shared central space can foster a strong sense of community and social cohesion.
- **Defensive or symbolic significance:** In some cases, the circular or semi-circular layout might have been chosen for its defensive advantages in historical contexts or due to its symbolic meaning within the community.

Global Examples

- **European villages:** Quaint villages like La Roque-Gageac in France and Lindisfarne in England showcase distinct circular or semi-circular layouts, often centered around a church or historical site.
- **African Kraals:** Traditional Kraals in southern Africa, like those of the Zulu and Masai people, often exhibit circular layouts with houses arranged around a central cattle enclosure.

Indian Examples

- **Tribal settlements in Northeast India:** Some tribal communities in Northeast India, like the Apatani tribe, might have settlements with circular or semi-circular outlines influenced by specific cultural practices or beliefs.
- **Temple towns in South India:** Certain temple towns in South India, like Madurai and Thanjavur, showcase concentric circular patterns radiating outwards from the central temple complex, reflecting religious significance and historical development.
- **Hillside villages in the Himalayas:** In the challenging terrain of the Himalayas, some villages adopt circular or semi-circular layouts to adapt to the slopes and maximize usable land.

Chessboard Or Grid-Iron Pattern

At the heart of chessboard and grid-iron patterns lies a **fundamental principle: order.** Houses are meticulously positioned along intersecting streets, forming a grid-like layout that resembles a **chessboard or a gridiron** (American football field).

Characteristics

- **Flat, fertile plains:** Grid patterns thrive on flat landscapes, where the even topography facilitates the establishment of straight roads and organized development.
- **Efficient land use:** The grid layout minimizes wasted space and allows for optimal utilization of land for both housing and agricultural activities.
- **Resource sharing and accessibility:** Shared infrastructure like water channels, sanitation systems, and electricity can be easily planned and implemented within the grid, promoting resource accessibility for all residents.
- **Sense of order and community:** The orderly arrangement can foster a sense of community and shared identity among residents, while also facilitating navigation and communication within the settlement.

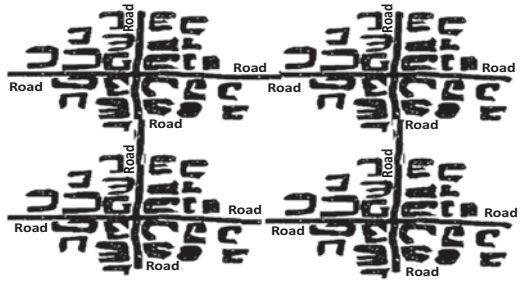


Fig. 6.15: Checker Board type of Settlement

Global Examples

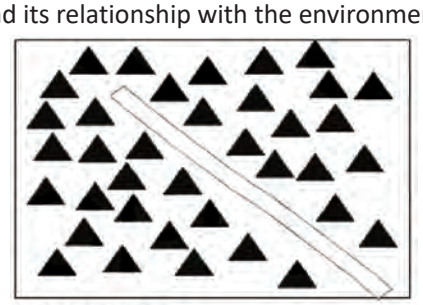
- **American farm towns of the Midwest:** The vast plains of the American Midwest are dotted with countless towns and villages exhibiting grid-iron patterns, reflecting the historical influence of land surveys and agricultural development.
- **Chinese farming communities:** Many villages in China's fertile plains, like Pingyao and Zhouzhuang, feature grid patterns with houses arranged in grid-like formations, reflecting a long history of planned agrarian settlements.

Indian Examples

- **Villages in the Indo-Gangetic Plain:** The fertile plains of North India, particularly in states like Punjab and Haryana, are home to numerous villages with distinct grid layouts, reflecting the influence of land surveys and planned agricultural development during the British era.
- **Planned towns and cities:** Several planned towns and cities in India, such as Chandigarh and Gandhinagar, were established with grid layouts, aiming for efficient resource management and infrastructure development.
- **Traditional settlements in South India:** Some temple towns in South India, like Madurai and Tanjore, showcase grid patterns radiating outwards from the central temple complex, reflecting historical planning and religious significance.

Amorphous Pattern

Unlike their neatly organized counterparts, amorphous settlements embrace a **more fluid and organic approach to spatial arrangement**. These settlements, characterized by a seemingly **random scattering** of houses amidst fields, forests, or natural landscapes, offer a unique perspective on rural life and its relationship with the environment.



Amorphous Pattern

Fig. 6.16: Amorphous Pattern

Characteristics

- **Scattered layout:** Houses are not arranged in any particular pattern, but rather dispersed across the landscape, often following natural contours or existing pathways.
- **Limited infrastructure:** Shared infrastructure like paved roads, grids, and formal public spaces might be scarce or absent, requiring residents to rely on individual resources and ingenuity.
- **Strong connection to nature:** Amorphous settlements often coexist closely with the surrounding environment, fostering a deep connection between residents and the natural world.
- **Self-sufficiency and independence:** Residents often rely heavily on their own skills and resources for farming, animal husbandry, or other income-generating activities, promoting self-sufficiency.
- **Unique social dynamics:** Social interactions might occur primarily within families or through occasional gatherings, creating a distinct and informal social fabric compared to closely knit communities.

Global Examples

- **American ranches and homesteads:** Vast stretches of land in the American West are dotted with isolated ranches and homesteads, where families raise livestock and manage extensive agricultural operations.
- **Scandinavian farmlands:** In countries like Sweden and Norway, individual farmsteads stand amidst idyllic landscapes, reflecting a long tradition of independent farming practices.
- **Mongolian nomadic settlements:** The nomadic communities of Mongolia live in transportable dwellings called gers, moving across vast grasslands following seasonal patterns for grazing their livestock.

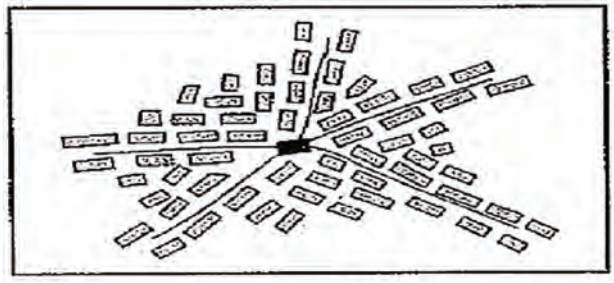
Indian Examples

- **Tribal villages in hilly regions:** The Himalayan foothills and tribal belts of Central India often feature amorphous settlements, shaped by the challenging terrain and reliance on shifting cultivation or hunting-gathering practices.
- **Desert settlements in Rajasthan:** The Thar Desert in Rajasthan is home to scattered villages and nomadic communities adapting to the harsh arid environment through unique livelihood strategies.
- **Forest settlements in Northeast India:** Some indigenous communities in the Northeast, like the Apatani tribe, traditionally live in dispersed settlements within dense forests, practicing sustainable resource management and maintaining a close connection to nature.

Star-Like Pattern

A star-like pattern of rural settlements refers to a settlement layout or distribution in which rural or agricultural communities are **arranged in a radial or star-shaped pattern**.

This type of settlement pattern typically has a central point from which roads, paths, or other forms of transportation radiate outward, resembling the spokes of a wheel or the arms of a star.



Star-like Pattern

Fig. 6.17: Star Like Pattern

Characteristics

- **Central focus point:** Houses are situated along roads or paths that converge at a central point, which could be a market square, a well, a religious site, or simply a crossroads.
- **Radiating layout:** Streets branch out from the central point, creating "arms" of the star and defining distinct neighborhoods or clusters of houses.
- **Efficient access:** Residents often enjoy convenient access to shared resources and amenities located at the central point.
- **Strong sense of community:** The central gathering space and radiating layout can foster a strong sense of community and social interaction among residents.
- **Historical or symbolic significance:** In some cases, the star-like pattern might have been chosen for its defensive advantages in historical contexts or due to its symbolic meaning within the community.

Global Examples

- **Medieval European towns:** Several European towns, like Laon in France and Gruyères in Switzerland, showcase star-like layouts, often centered around a fortified castle or religious complex.
- **American frontier towns:** Some 19th-century American frontier towns, like Deadwood in South Dakota, were planned with star-like layouts, with saloons and businesses radiating outwards from a central plaza.

Indian Examples

- **Hillside villages in the Himalayas:** In the challenging terrain of the Himalayas, some villages adopt star-like layouts to adapt to the slopes and maximize usable land around a central water source or shared space.
- **Temple towns in South India:** Certain temple towns in South India, like Kanchipuram, showcase concentric radiating patterns around the central temple complex, reflecting historical development and religious significance.

- **Tribal settlements in Northeast India:** Some indigenous communities in the Northeast, like the Chakma tribe, might have settlements with star-like outlines influenced by specific cultural practices or beliefs.

Other Patterns

Various other settlement patterns include **T-Shaped, Y-Shaped And L-Shaped** depending on how roads intersect. Additionally, in the foothills of mountains, settlements may take on a **fan-shaped pattern,** resembling the shape of a hand fan.

Indian Villages

Indian villages are rustic settlements, where people lead a simple life connected to nature. Surrounded by fields and greenery, villagers engage in agriculture, traditional crafts, and communal living, embodying the rich cultural tapestry of India.

Features of Settlements in Indian Villages

- **Cultural Pillars and Indian Village Traditions:** Indian villages are regarded as the foundational elements of Indian culture. Indian villages are predominantly steeped in tradition and adhere to established customs and practices.
- **Diverse construction materials:** Construction materials commonly used in villages encompass mud, unfired and fired bricks, stone fragments, thatch, wood, and grasses.
- **Bountiful village landscapes:** Villages typically have surrounding groves of trees and orchards, with coastal villages featuring coconut palm, areca nut, and banana trees.
- **Community spaces:** Public areas shared by the entire village community include ponds, temples/mosques, wells, meeting spaces, graveyard s, and cremation grounds.
- **Social hierarchy in village settlements:** The central and elevated sections of village settlements are typically occupied by upper-caste cultivators.
- **Role of courtyards:** Courtyards are a common feature of Indian villages, serving as storage spaces for livestock fodder and agricultural tools.
- **Rural settlements in the Himalayas:**
  - In the **Himalayas region**, settlements vary from compact to dispersed. **Intermontane valleys** have mostly compact or semi-compact villages, while higher altitudes feature dispersed settlements due to hilly terrain.
  - **Communities like** Gujjars and Bakarwals practice transhumance, with permanent winter houses and temporary summer ones.
  - **Himalayan states**, with steep slopes and diverse tribes, often have small and widely dispersed villages. Famous Himalayas villages include Ghangaria, Munsiyari, and Tawang.
- **Rural settlements in the northern plains of India:**
  - Plains in Punjab, Haryana, and Western Uttar Pradesh boast highly productive, irrigated farmlands with large, compact settlements. Bhangar tracts **feature compact or semi-compact villages**, while khadar and bet lands along rivers result in semi-compact, scattered, or dispersed settlements due to seasonal flooding.
  - **Western Rajasthan** has semi-compact, and eastern Rajasthan has compact and large settlements. Tarai tracts exhibit semi-compact, medium-sized settlements with uneven distribution. **Middle Ganga plain** settlements are semi-compact, small, and closely spaced.
  - **Lower ganga plains** show scattered settlements influenced by hydrological factors, such as in rahr plain, duars, and Sundarban Delta.
  - **Brahmaputra valley villages** along river levees are smaller and separated, adopting a machan style in flood-prone areas with boats as primary transport.
- **Rural settlements in peninsular India:**
  - **Peninsular India's** varied terrain results in a mix of rural settlement types. In the hilly Aravalli region, huts are scattered within village lands, while dissected hills like Mewar and Alwar have isolated Dhani farmsteads in narrow valleys.
  - **Jaipur and nearby areas** have compact and semi-compact settlements, but the Udaipur division in southern Aravalli exhibits isolated and dispersed settlements.

Fig. 6.18: Distribution of Villages in India.

- **The lava-plateau region** between Pune and Solapur shows semi-compact and dispersed settlements. Karnataka's maidan and Rayalaseema regions have widely spaced compact settlements, whereas the hilly Malnad area has semi-compact ones.
- **The Kaveri delta and coastal regions** include both compact and semi-compact settlements, while the sahyadris are dominated by isolated settlements.

❑ **Rural settlements in the coastal regions:**

- **In delta regions like Mahanadi, Godavari, Krishna, and Kaveri,** settlements sit atop elevated levees to avoid floods, fostering compact layouts due to intensive farming.
- **Along the eastern coast**, various fishing villages with different shapes and patterns can be found.
- **The Malabar coast** features primarily large and compact settlements, with scattered and dispersed ones in coconut and cashew plantation areas.
- **In the Rann of Kutch,** smaller semi-compact and scattered settlements with one or two rooms are widely spaced.

Changing Pattern of Rural Settlements

The world of rural settlements is **not static**. Rural communities are constantly evolving, and adapting to changing circumstances and influences. These shifts in settlement patterns offer fascinating insights into the **interplay between social, economic, environmental, and technological factors**.

Drivers of Change:

❑ **Urbanization and rural-urban migration:** As cities expand, rural communities near urban centers experience population loss and changes in land use, often transitioning from agricultural activities to peri-urban functions.

- **Rapid urbanization:** India's urban population is projected to be more than 50% by 2030, with a significant share migrating from rural areas (World Bank, 2022).
- **UN Report:** Urban populations are projected to reach 68% globally by 2050, with most growth in Asia and Africa. This rapid urbanization puts pressure on peri-urban areas to manage land-use changes and infrastructure needs.

❑ **Technological advancements:** The rise of communication technologies and remote work opportunities allows people to live in rural areas while accessing urban amenities and jobs, potentially leading to population dispersal and the emergence of new types of rural communities.

- **Mobile phone penetration:** Over 80% of rural households now own mobile phones, enabling access to information, financial services, and e-commerce (Statista, 2023).
- **OECD Report (2023):** The rise of remote work could lead to a increase in rural populations in OECD countries by 2030. However, digital infrastructure disparities and access to broadband remain challenges.

❑ **Environmental concerns:** Climate change, resource depletion, and natural disasters can force rural communities to relocate or adapt their settlement patterns, often seeking safer and more sustainable locations.

- **Rural-urban waste management:** Growing volumes of waste pose challenges for both rural and urban areas, necessitating waste reduction and decentralized management solutions.
- **IPCC Sixth Assessment Report (2022):** Climate change-induced droughts and extreme weather events are displacing rural communities, particularly in vulnerable regions like sub-Saharan Africa and South Asia.

❑ **Economic shifts:** Changes in agricultural practices, globalization, and economic policies can impact rural livelihoods and lead to shifts in population density and settlement patterns.

- **Growth of small and medium enterprises (SMEs):** Rural entrepreneurship is on the rise, driven by government initiatives and digital platforms, boosting rural economies.
- **FAO Report (2023):** The decline of traditional agricultural practices and rural livelihoods in developing countries is pushing young people towards urban migration. Investments in rural infrastructure and value chains are crucial for retaining populations.

❑ **Government policies:** Rural development programs, infrastructure projects, and land-use regulations can influence the location, size, and infrastructure of rural settlements.

- **National Rural Development Mission (NRDM):** This flagship program aims to improve rural infrastructure, create livelihoods, and enhance social services. It includes schemes like Pradhan Mantri Gram Sadak Yojana (rural roads), Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), and Swachh Bharat Abhiyan (rural sanitation).
- **Smart Villages Initiative:** This initiative aims to transform rural settlements using technology, focusing on e-governance, digital literacy, and smart infrastructure.
- **Deendayal Upadhyaya Gram Swarajya Yojana (DDU-GSY):** This scheme encourages panchayats (local self-governing bodies) to plan and implement infrastructure development projects in their villages.

Examples of Changing Patterns

❑ **Abandoned villages in Europe and North America:** Depopulation due to urbanization and economic shifts has led to the abandonment of numerous villages in these regions.

IGNITE YOUR MIND

Ghost Towns of the Future?: With automation and remote work on the rise, could some cities shrink or even become ghost towns, and what challenges and opportunities might this present?

- **New rural communities in Southeast Asia:** Technological advancements and economic opportunities have attracted people to rural areas in Southeast Asia, leading to the development of new types of settlements.
- **Urbanization of villages in China:** Rapid economic growth in China has led to the urbanization of many villages, blurring the lines between rural and urban areas.
- **Ghost villages in Uttarakhand and Himachal Pradesh:** Villages in these Himalayan states face depopulation due to harsh terrain, limited livelihood options, and migration to cities.
- **Tourism villages in Rajasthan and Goa:** Villages in these states embrace tourism and adapt their settlements to cater to visitors, showcasing traditional crafts and cultural experiences.

Consequences of Change

- **Loss of traditional rural cultures and landscapes:** Depopulation and changes in land use pattern can threaten traditional ways of life and the unique character of rural communities.
- **Challenges for rural infrastructure and services:** Declining populations can make it difficult to maintain essential services like healthcare, education, and transportation in rural areas.
- **Environmental impacts:** Sprawl and changes in land use can have negative consequences for biodiversity, water resources, and agricultural productivity.
- **Emergence of new rural forms:** Technological advancements and changing lifestyles can lead to the development of new types of rural communities, such as co-housing communities, eco-villages, and retirement communities.
- **Increased social and economic inequalities:** Unequal access to resources and opportunities can exacerbate existing inequalities between rural and urban areas.

Issues of Rural Settlements

Rural settlements, despite their undeniable charm and **vital role in food production and resource management,** face a multitude of complex challenges. These issues, stemming from **various interconnected factors,** impact the well-being, development, and sustainability of these communities.

Disaster Vulnerability

- **Natural Disasters:** Prone to floods, droughts, cyclones, and earthquakes, rural communities often lack the infrastructure and resources to cope with the aftermath.
  - The **2023 Global Climate Risk Index ranked** India as the **eighth most vulnerable country** to climate change impacts.
- **Climate Change:** Rising temperatures, erratic rainfall patterns, and extreme weather events further exacerbate existing vulnerabilities.
  - The **Intergovernmental Panel on Climate Change's Sixth Assessment Report** highlights the disproportionate vulnerability of rural communities to climate change.

Lack of Public Service Infrastructure

- **Limited access to basic necessities:** Clean water, sanitation facilities, reliable electricity, and healthcare services are often scarce.
  - Only 59% of rural households have access to tap water supply, and 19% households still have no toilet facility.
  - 6% of rural healthcare facilities lack qualified doctors **(Lok Sabha Question, 2020).**
- **Poor transportation infrastructure:** Inadequate roads, limited public transportation options, and lack of vehicle ownership restrict mobility and access to essential services.
  - Only 70% of rural villages are connected by all-weather roads **(PM Gram Sadak Yojna).**

Unplanned Settlements

- **Haphazard growth:** Many rural settlements arise organically without proper planning, leading to overcrowding, inadequate drainage systems, and environmental degradation.
  - According to a 2022 report by the **Centre for Science and Environment (CSE)**, many of of India's rural settlements lack formal planning, exacerbating issues like overcrowding, inadequate infrastructure, and environmental degradation.

Unchecked Urban Sprawl

- **Loss of agricultural land and livelihoods:** Uncontrolled urban expansion can lead to the conversion of fertile agricultural land for non-agricultural purposes, impacting rural livelihoods.
  - Over 1.6 million hectares of agricultural land were converted for non-agricultural purposes between 2000 and 2020, according to a 2023 report by the **Land Conflict Watch India (LCWI)**.

IGNITE YOUR MIND

Disaster-Proof Paradises or False Promises?: Can cities be truly "disaster-proof," and what ethical issues arise when focusing resources on protecting specific areas while leaving others vulnerable?

Major Steps Taken Related To Rural Settlement

Infrastructure Development

- **Water supply and sanitation:** Providing clean drinking water and proper sanitation facilities is crucial for health and hygiene in rural areas. This can involve installing pumps, wells, and sewerage systems.
  - **Example:** The Swachh Bharat Abhiyan (Clean India Mission) has significantly improved sanitation access in rural India, constructing millions of toilets and promoting hygiene awareness.
- **Electricity and connectivity:** Access to electricity is essential for basic needs like lighting, communication, and powering appliances. Additionally, internet connectivity facilitates education, healthcare, and economic opportunities.
  - **Example:** The SAUBHAGYA Scheme focuses on electrifying all villages in India, with significant progress made in recent years.
- **Transportation:** Building and maintaining roads, bridges, and public transportation systems improves mobility and connects rural communities to markets, healthcare, and education centers.
  - **Example:** The Pradhan Mantri Gram Sadak Yojana aims to connect all habitations with over 250 people in India through paved roads, boosting rural mobility and economic activity.
- **Agriculture and agro-processing:** Investing in irrigation, farming technologies, and cold storage facilities can boost agricultural productivity and income for farmers. Supporting agro-processing industries adds value to agricultural products and creates jobs.
  - **Global Example:** The Sustainable Agricultural Intensification and Market Expansion (SAIME) Project in Ethiopia supported smallholder farmers through improved farming practices, market linkages, and access to finance.
  - **Indian Example:** The National Mission on Sustainable Agriculture (NMSA) promotes organic farming, soil health management, and climate-resilient agriculture practices to enhance productivity and farmer income.

Social Development

- **Education and healthcare:** Ensuring access to quality education and healthcare services through schools, primary healthcare centers, and telemedicine initiatives is crucial for improving the overall well-being of rural communities.
  - **Global Example:** The Education Fast Track Initiative (EFTI) in Pakistan improved access to primary education in rural areas through teacher training and infrastructure development.
  - **Indian Example:** The National Health Mission (NHM) has established a network of rural health centers and sub-centers to provide basic healthcare services in rural India.
- **Social welfare programs:** Implementing programs like pensions for the elderly, maternity benefits, and disaster relief can provide much-needed social safety nets for vulnerable populations.
  - **Global Example**: The Social Safety Net program in Brazil provides financial assistance to low-income families, improving their living standards and reducing poverty.
  - **Indian Example:** The Pradhan Mantri Jan Dhan Yojana promotes financial inclusion by providing bank accounts and access to financial services in rural areas.

Environmental Sustainability

- **Renewable energy:** Harnessing renewable energy sources like solar power and biogas can provide clean energy solutions for rural communities and reduce reliance on fossil fuels.
  - **Global Example:** The Lighting Rural Africa initiative provides solar power solutions to off-grid rural communities, reducing reliance on fossil fuels and improving energy access.
  - **Indian Example:** The Pradhan Mantri Sahaj Bijli Har Ghar Yojana aims to provide solar power systems to unelectrified households in rural India.
- **Disaster preparedness and mitigation:** Implementing measures like early warning systems, flood control infrastructure, and climate-resilient agriculture practices can help rural communities cope with natural disasters.
  - **Global Example:** The Sendai Framework for Disaster Risk Reduction promotes community-based disaster preparedness and risk reduction strategies worldwide.
  - **Indian Example:** The State Disaster Management Authorities (SDMAs) in India implement disaster preparedness plans, conduct mock drills, and educate communities to mitigate the impact of natural disasters.

Way Forward

- **Empowering Self-Help Groups:**
  - Self-help groups led by **women create significant social capital**, fostering human development, providing access to credit, supporting entrepreneurship, and **contributing to sustainable poverty reduction** through diverse livelihoods.
- **Collaboration with Local Government:**
  - **Collaboration** between self-help groups and the 3.3 million elected local government leaders, of which 43% are women, has transformative potential.

- **Providing Necessary Skill Sets:**
  - Local governments need **specific skill sets** to effectively manage the 29 subjects and ensure better governance outcomes.
  - **Key focus areas** for improvement include human resources, technology integration, mentorship, and strategic partnerships.
  - Recommendations from the **Sumit Bose Committee,** which addressed rural development issues, can serve as guiding principles.
- **Utilizing MGNREGS:**
  - Positioning MGNREGS as a **decentralized resource** can aid in poverty reduction, climate change mitigation, and overall well-being.
  - The **program's scalability** allows for increased support during times of severe distress, with proven effectiveness in water conservation, infrastructure development, and income generation.

In conclusion, the strides in rural development encompass **robust infrastructure,** economic empowerment, social upliftment, and environmental sustainability. The **collaboration between self-help groups, local governments**, and targeted programs demonstrates a holistic approach to addressing diverse challenges. As **rural India progresses**, the emphasis on skill development, self-sufficiency, and inclusive policies remains pivotal for sustained growth and improved quality of life. Leveraging successful models and **prioritizing community engagement** will pave the way for a more resilient and prosperous rural landscape.

URBAN SETTLEMENTS

Urban settlement refers to the concentrated human habitation characterized by **high population density, extensive infrastructure, and diverse economic activities**. Unlike rural areas, urban settlements are marked by the presence of towns and cities, showcasing advanced levels of social, economic, and cultural development.

Urban areas typically **feature various amenities** such as transportation networks, educational institutions, healthcare facilities, and commercial centers. The growth of urban settlements is often driven by factors like industrialization, economic opportunities, and migration. The study of urbanization is crucial for **understanding the dynamics of modern societies** and the challenges associated with managing complex urban environments.

IGNITE YOUR MIND

Tiny Town or Megalopolis: What defines a city? Is it size, population, or something more? Can a small town have a big-city vibe?

History of Urbanization

Ancient

- **Mesopotamia (5,000 BCE):** The fertile Tigris and Euphrates rivers nurtured the first urban civilizations like Uruk and Ur, driven by agricultural surpluses and the need for centralized governance.
- **Indus Valley Civilization (2,600 BCE):** Mohenjo-Daro and Harappa showcased sophisticated urban planning, with grid-like street layouts, advanced drainage systems, and monumental architecture.
- **Yellow River Valley (2,000 BCE):** China's early cities like Anyang thrived under the Shang dynasty, boasting bronze technology, complex social structures, and ritualistic practices.

Medieval

- **Mediterranean Europe (500-1500 CE):** Ancient Roman cities like Pompeii and Constantinople evolved into medieval centers of trade and religion, surrounded by fortified walls and bustling marketplaces.
- **Islamic World (7th-13th CE):** Baghdad, Damascus, and Cairo blossomed as intellectual and cultural hubs, serving as centers of learning, scientific advancements, and artistic expression.
- **Mesoamerica (300-900 CE):** Teotihuacan in Mexico and Tikal in Guatemala showcased monumental architecture, complex societies, and intricate religious practices, reflecting the advanced urban civilizations of the Americas.

Industrial Revolution

- **18th-19th Centuries:** The Industrial Revolution triggered a seismic shift, with cities like London, Manchester, and New York transforming into factory hubs. Steam power, mechanization, and the rise of capitalism fueled rapid population growth and reshaped urban landscapes.
- **Social and political changes**: This era witnessed overcrowding, slums, and social unrest, leading to reforms in sanitation, housing, and labor laws, shaping the modern face of cities.

20th and 21st Century Megacities

Megacities are urban areas with a **population exceeding 10 million residents**. The terms **Megapolis or Megalopolis** are occasionally employed interchangeably with Megacity. As of the year 2015, there are 35 megacities worldwide. The **United Nations anticipates** that the number will **increase to 41 by the year 2030**. In India, there are currently **four megacities**: Delhi, Mumbai, Kolkata, and Bengaluru.

Megacity

A megacity is a metropolitan area with a population of **at least 10 million people**. It can be a single metropolitan area or two or more metropolitan areas that converge.

- **Focus:** Defined primarily by population size, exceeding 10 million inhabitants.
- **Characteristics:** Densely populated urban areas with significant economic activity, but not necessarily dominant global influence.
- **Examples**: Tokyo, Delhi, Shanghai, Mexico City, São Paulo.

Global City

Global cities are hubs within the **globalized economic system** and have significant competitive advantages. They are **command and control centers for the global economy**, organizing the material, financial, and cultural flows that sustain globalization.

- **Focus**: Defined by global influence and interconnectedness, regardless of population size.
- **Characteristics:** Leading centers of finance, trade, technology, and culture, wielding significant power on the global stage.
- **Examples**: London, New York City, Tokyo, Paris, Hong Kong etc.

Key Differences

- **Population:** While some global cities are also megacities (e.g., Tokyo, London), not all megacities are global cities. Smaller cities like Amsterdam or Zurich can have significant global influence without exceeding the 10 million population threshold.
- **Emphasis:** Megacities focus on scale and density, while global cities focus on connectivity and influence.
- **Examples**: Some cities, like Los Angeles or Mumbai, might be considered megacities due to their population but lack the global interconnectedness of a truly global city.

Overlapping Features

- Both megacities and global cities are **hubs of economic activity, cultural diversity, and innovation.**
- Both face similar challenges in **managing infrastructure, resources, and social issues.**
- Both play important roles in **shaping the future of our increasingly urbanized world.**

Recent Trends

- **Global Urbanization:** Today, urbanization continues at an unprecedented pace, with developing countries like China, India, and Brazil experiencing explosive growth. Megacities like Tokyo, Shanghai, and Delhi have emerged as powerful economic and cultural forces.
- **Challenges and opportunities:** Contemporary cities grapple with issues like pollution, traffic congestion, and social inequalities. However, they also offer unparalleled opportunities for innovation, education, and cultural exchange.

IGNITE YOUR MIND

From Megacities to Megaregions?: As urban areas merge into vast interconnected zones, what are the potential benefits and drawbacks in terms of economic power, cultural diversity, and governance?

Factors Influencing Urbanisation

Administration

- The intricate relationship between urbanization and administration has profoundly shaped human settlement throughout history.
- From the earliest Mesopotamian city-states to the sprawling metropolises of today, the way we **govern and manage urban spaces** has continuously evolved in tandem with their growth and complexity.
- **Example: During Mughal rule, the** Development of trade routes and planned cities like Agra and Fatehpur Sikri led to population growth and economic activity.
- **Mesopotamia's city-states** like Ur and Babylon housed complex administrative structures, with ziggurats serving as religious and governmental centers.

Religion

- The evolution of urbanization by religion refers to the **changing patterns and characteristics** of urban development within specific religious communities or contexts.
- It involves examining how **different religious groups** or affiliations contribute to or are influenced by the growth, structure, and dynamics of urban Settlements.
- **Example: Hindu pilgrimage centers like:** Varanasi, Mathura, and other holy cities have attracted and sustained large urban populations for centuries.
- Consider Teotihuacan in Mexico, a pre-Columbian city famed for its monumental pyramids and temples, showcasing the **central role of religion** in urban life.

Cultural exchange

- Cities have **never been isolated islands**. From the earliest settlements to sprawling metropolises, they've thrived on the **vibrant exchange of ideas, customs, and traditions.**
- This cross-pollination of cultures has profoundly shaped the very way cities grow, evolve, and pulsate with life.
- **Example: Universities and educational centers:** Nalanda and Takshashila, ancient centers of learning, attracted

students from across Asia, contributing to urban development.

- The Athenian Agora in ancient Greece served as a busy marketplace and forum for **philosophical and artistic exchange,** highlighting the social and cultural aspects of urban centers.

Technological advancements

- Technological advancements play a significant role in influencing urbanization by shaping the way cities are designed, operated, and experienced.
- **Example: Sushruta,** a surgeon, performed complex surgeries and documented his knowledge in the Sushruta Samhita, influencing medical practices worldwide.
- The Roman Empire's extensive network of roads and aqueducts, like the Pont du Gard, **facilitated transportation and water supply,** enabling the growth of cities like Rome.

Economic opportunities

- Economic opportunities emerged as a powerful force, propelling **individuals and communities to migrate** from rural areas to burgeoning cities.
- This historical interplay between urbanization and economic pursuits has been marked by transitions such as the **rise of agricultural surpluses,** the **impact of industrialization,** and the **influence of trade routes**, each contributing to the formation and expansion of urban landscapes.
- **Example: Indus Valley cities** like Mohenjo-daro and Harappa flourished due to trade and craft production, attracting skilled workers and merchants.
- The industrial revolution spurred the rise of factory towns like **Manchester in England**, attracting migrants with the promise of jobs and economic prosperity.

Social and cultural pull

- Across centuries, the allure of **cultural diversity, intellectual enlightenment, spiritual significance, and vibrant artistic communities** has transformed urban landscapes into melting pots of human experience.
- The interplay between social mobility, communal bonds, and the pursuit of a cosmopolitan lifestyle has **not only defined the physical expansion** of cities but has also woven the very fabric of urban life.
- **Example:** Centers renowned for specific crafts, like **Kanchipuram for silk weaving**, attracted artisans and fostered urban communities.
- Consider the allure of Renaissance Florence, a magnet for artists, scholars, and patrons like the Medici family, fostering a vibrant cultural scene.

These factors of urbanization can be further divided into push and pull factors.

Push Factors

- **Definition:** Social, cultural, environmental, and political factors that drive migration away from one's homeland.
- **Contrast with Pull Factors:** While push factors induce departure, pull factors attract individuals to new destinations.

Push Factor	Description	Example
Hunger or Famine	Displacement caused by famine resulting from drought, civil war, and government policies.	Ethiopian famine of 1984, forced over 1.5 million people to leave.
Climate Change	Anticipated major push factor with up to 200 million climate refugees by 2050.	Anticipated climate change impact causing massive migration by 2050.
Exile	Forced departure due to government actions.	Dali Lama's forced exile from Tibet to India in 1959.
Political Repression	Migration driven by political oppression.	Opposition figures fleeing Russia after the 2022 invasion of Ukraine.
Gender Discrimination	Women fleeing discrimination and violence.	Malala Yousafzai fleeing Pakistan after Taliban attack.
Religious Persecution	Migration due to persecution based on religious beliefs.	Yazidis fleeing Iraq to seek asylum.
Homophobia	Migration driven by discrimination against LGBTQ+ individuals.	LGBTQ+ individuals leaving Russia due to anti-gay laws.
Racism	Migration due to racial discrimination.	Great Migration of African Americans from the rural south to the urban north in the early 20th century.

Ethnic Cleansing	Forced migration to remove a specific ethnic group.	Bosnian genocide displaced over 2 million people.
Forced Conversion	Migration driven by forced religious conversion.	Christians in Pakistan fleeing due to forced conversion threats.
Poverty	Migration for better economic opportunities.	Central African Republic residents moving to neighboring countries due to civil war-induced poverty.
Lack of Educational Institutions	Seeking quality education in other countries.	International students moving to the USA for higher education.
Lack of Healthcare	Migration for better healthcare.	Residents leaving Flint, Michigan, due to contaminated water.

Individuals leave their residences for **diverse reasons**. Some embark on this journey to escape persecution, while others do so due to a lack of resources, and limited access to quality healthcare or education. Often, people leave their homes because they feel unsafe or seek refuge from corrupt societal conditions. These **various motivations** collectively fall under the category of **'push factors,'** as each factor serves as a compelling force propelling individuals to migrate to a more favorable destination.

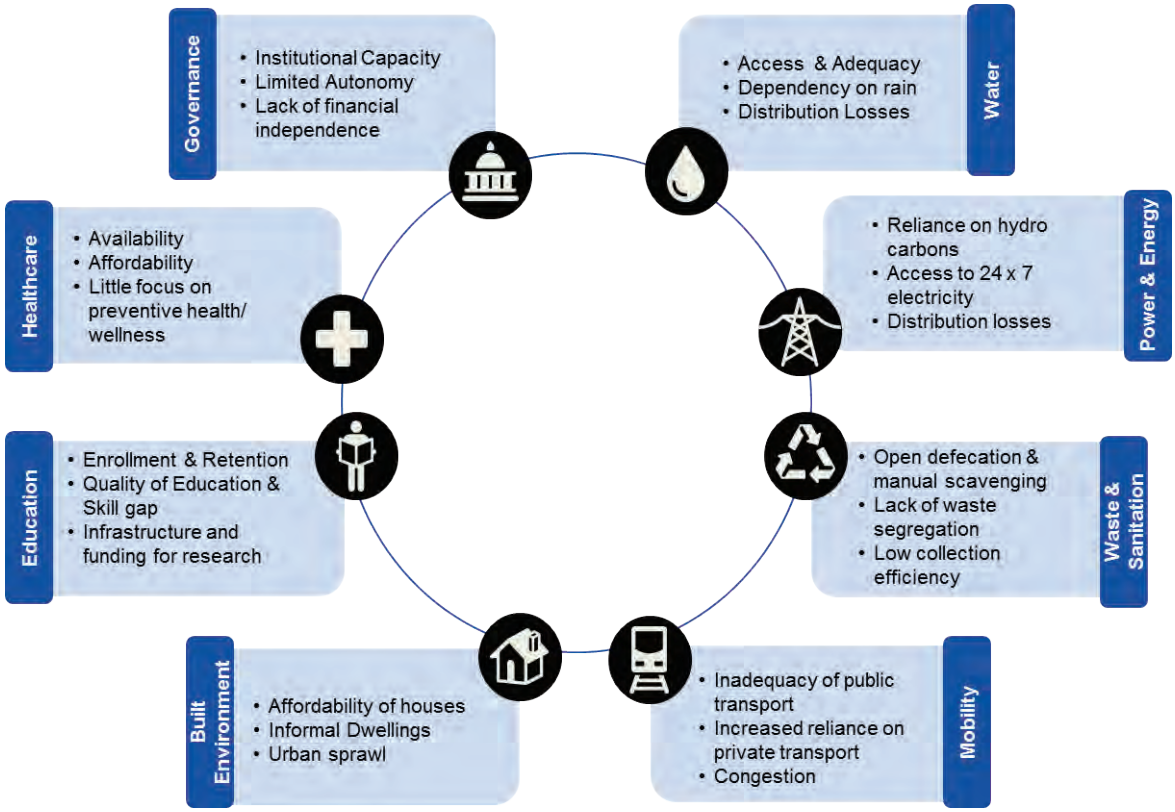


Fig. 6.19: Problems In Rural Areas

Pull Factors

- **Definition: Pull factors** refer to the elements that make a destination appealing to migrants. While individuals forced to migrate due to factors like war or famine may have limited choices, **voluntary migrants** often have the opportunity to carefully consider their destination. In the decision-making process, they assess various pull factors such as climate, healthcare, employment opportunities, and overall quality of life.

Factor	Description	Example
Economic Stability	Economic instability prompts emigration; migrants seek better opportunities.	Migration from economically unstable nations like Libya and Syria to economically stable Western European countries.

Social Stability	Desire for harmonious communities with low crime rates influences migration decisions.	Choosing cities with less social unrest and fewer protests.
Cultural Factors	Attraction to countries with similar or different cultures.	Muslim students favoring Dubai due to cultural alignment.
Natural Beauty	Scenic landscapes such as mountains, beaches, or jungles attract migrants.	Europeans migrated to Australia for its stunning beaches.
Climate/Weather	Migration influenced by preferences for certain climates.	Americans migrating to warmer climates like Florida during winter.
Proximity to Friends and Family	Chain migration, where people move to be near family and friends.	Specific visa schemes like the family-based green card in the United States.
Affordability	Assessment of living costs influences migration decisions.	Internal migration within the U.S. towards more affordable cities like Austin, Texas.
Safety and Security	Migration driven by concerns about safety in home countries.	Venezuelans migrating to Colombia due to high violence levels in Venezuela.
Quality of Life/ Standard of Living	Subjective factors such as national holidays, services, and work/life balance are considered.	Migration from developing to developed countries for better opportunities.
Language	Common language as an appealing factor, especially for those with limited language options.	Portuguese speakers favoring Brazil over English-speaking countries.
Religious Tolerance or Freedom	Seeking countries where religious practices are accepted without discrimination.	Consulting religious freedom indexes to find desirable countries.
Gender Equality	Consideration of gender equality when moving countries.	Rankings of Scandinavian countries attracting those seeking gender parity.

These pull factors are **dynamic and can undergo changes over time**. For example, a location that was previously recognized for abundant natural resources might experience a decline in population as those resources diminish. Conversely, an area once deemed economically disadvantaged could become more attractive if new businesses emerge, generating employment opportunities.

Types of Urban Settlements

Urban settlements come in diverse forms, reflecting the **dynamic nature of human habitation** in urbanized areas. These settlements vary in size, structure, and function, contributing to the intricate tapestry of urban landscapes.

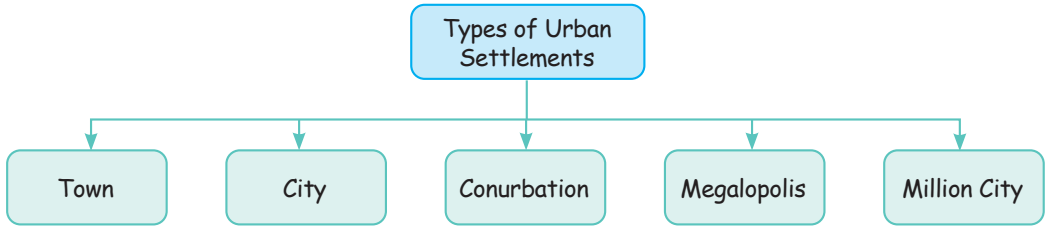


Fig. 6.20: Types of Urban Settlements

- Understanding the types of urban settlements is essential for comprehending the complexities of urban living, as it **involves a range of factors** such as population density, infrastructure, and socioeconomic activities. Some of them are given below:

On The Basis of Age

From ancient Hindu capitals like Ayodhya to **medieval Muslim-influenced** Shahjahanabad, India's urban evolution is a rich tapestry. **British colonialism reshaped cities**, introducing railways and distinct zones. **Post-independence**, planned urban centers like Chandigarh reflect thoughtful development. India's cities, spanning epochs, showcase a dynamic interplay of cultural, political, and economic influences.

Ancient Cities

- Many ancient cities served as the **capitals of Hindu kings**, with the royal palace at the core.
- Cultural sites like temples, Brahmin residences, and ministerial homes were often located near the palace.
- During the **Maurya Empire**, the southern part of the city was designated for Shudras, historically considered untouchables.
- Notable ancient towns included **Ayodhya, Bodh-Gaya, Hastinapur, Kanchipuram, Kapilvastu,** Madurai, Mathura, Patliputra (Patna), Rajgir, Vaishali, Varanasi, Ujjain, and Uraivur.

Medieval Cities

- Muslim influence during the medieval era introduced features like **fortifications, mosques, markets, crossroads, and residential** segregation.
- **Shahjahanabad (Old Delhi)** exemplifies this medieval urban layout, showcasing a blend of Islamic and Hindu design elements.
- Medieval cities were enclosed by brick walls but lacked defensive moats.
- Each city had a central market hub (chowk) with gated entrances for access control.

Modern Cities

- British colonial administration significantly **altered traditional Indian cities.**
- Expansion of **railways** and trade led to new urban settlement patterns.
- British introduced separate zones like **Civil Lines** and cantonments for the white population.
- Introduced small roads, green belts, recreational clubs, churches, gardens, and cemeteries, transforming urban morphology.

Post-independence, national and state governments developed cities with **thoughtful urban planning** and essential infrastructure.

- Cities like Bhilai, Bhubaneshwar, Bokaro, Chandigarh, Dispur, Faridabad, Noida, Gandhinagar, Gurgaon, Lavasa, Panchkula, Pantnagar, and Rourkela showcase post-independence urban development.
- Meticulously designed with essential amenities, these cities represent a new era of urban planning and growth.

On The Basis of Population

In India, bustling metropolises and quaint towns exist on a diverse spectrum, each playing a vital role in the country's vibrant tapestry. To understand this urban landscape, the **Census of India classifies towns** based on their population size, creating a system that helps analyze growth, resource allocation, and development needs.

Classification of Towns by the Census of India on the Basis of Population Size	
Town Class	**Population**
Class I	> 100,000
Class II	50000 - 100000
Class III	20000 - 50000
Class IV	10000 - 20000
Class V	5000 - 10000

On The Basis of Function

The **classification of cities** based on their roles and functions is referred to as functional classification of towns. **Urban functions** primarily encompass non-agricultural activities such as governance, industrial production, commercial activities, defense, the provision of goods and services, communication, and recreational facilities. In practice, cities are rarely strictly **mono-functional,** meaning that a single city can serve multiple functions simultaneously. The Indian cities may be classified under the following categories:

Administrative Cities

- Administrative cities or towns **primarily serve** the function of overseeing the governance and administration of a country, state, or other administrative regions.
- This **includes** not only national capitals but also regional centres, district headquarters, and other divisions responsible for administrative functions within the country.
- **Administrative cities** house the legislative, executive, and judicial branches of the respective administrative units.
- **Examples** of such administrative cities include New Delhi, Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Lucknow, Jaipur, Patna, Gandhinagar, Bhopal, Chandigarh, Shillong, Dispur, Aizawl, Kohima, and others.

Industrial Cities

- These cities are typically **strategically situated**, with good connectivity to both raw material sources and markets where finished products can be distributed and sold. This connectivity is **facilitated by** well-developed road and railway networks.
- Some notable **manufacturing centers** in India include Bhilai, Bhadrawati, Bokaro, Coimbatore, Dhanbad, Durgapur, Jamshedpur, Vijayanagaram, Visakhapatnam, and others.

Transport Cities

- These urban areas can either **serve as seaports** primarily involved in import and export operations, such as Kandla, Kochi, Kozhikode, Vishakhapatnam, and others, or act as pivotal locations for inland transportation, as exemplified by Agra, Dhulia, Mughalsarai, Itarsi, Katni etc.

Mining Cities

- These towns have emerged in **regions abundant with** mineral resources, including places like Raniganj, Jharia, Digboi, Ankaleshwar, Singrauli, and others.

Defence Town

- The **primary functions** of a defence town revolve around ensuring the security and defence of the nation.
- These towns **typically feature** cantonments, barracks, military training facilities, garrisons, air force bases, airfields, harbors, strategically important locations, and naval headquarters.
- **Examples** of such towns include Adampur, Ambala, Halwara, Jalandhar, Pathankot, Udhampur, Visakhapatnam, and others.

Religious Cities

- These cities fulfill roles **primarily centered around religious activities**.
- For instance, **cities like** Allahabad/Prayagraj, Amritsar, Ajmer, Bodh-Gaya, Dharamshala, Gangotri, Hardwar, Varanasi and others are religious centers where various religious ceremonies take place, and markets are abundant with religious literature and items essential for these rituals.

Educational Cities

- Originally established as **hubs of education**, certain towns have evolved into significant campus towns, including Roorkee, Varanasi, Aligarh, Pilani, Allahabad, And Others.

Tourist Cities

- Urban areas that primarily serve as destinations for **recreational activities** are referred to as tourist cities.
- These towns offer **various forms of leisure and recreation**, which can include health-giving natural springs, seaside attractions, mountain climbing, protected area networks, and locations known for their aesthetic beauty.
- **Examples** of such towns include Bageshwar, Dehradun, Dalhousie, Darjeeling, Dharamshala, Gulmarg, Kullu, Manali, Mount Abu And Others.

URBANISATION OF THE WORLD

Cities around the world are different from each other. Every continent is growing cities in its own way and has its own special features.

Current Urbanization Levels

As per the United Nation's 'World Urbanisation Prospects (2018) **56% of the world's population**, or 4.4 billion people, live in cities. This is up from around one-third in 1950. By 2050, the urban population is expected to more than double, with nearly 70% of the world's population living in cities.

- Asia is home to 54% of the world's urban population, followed by Europe and Africa with 13% each.
- **Urbanization rates by Continent:**
  - Northern America: 83%
  - Latin America and the Caribbean: 82%
  - Europe: 75%
  - Oceania: 68%
  - Asia: 53%
  - Africa: 44%

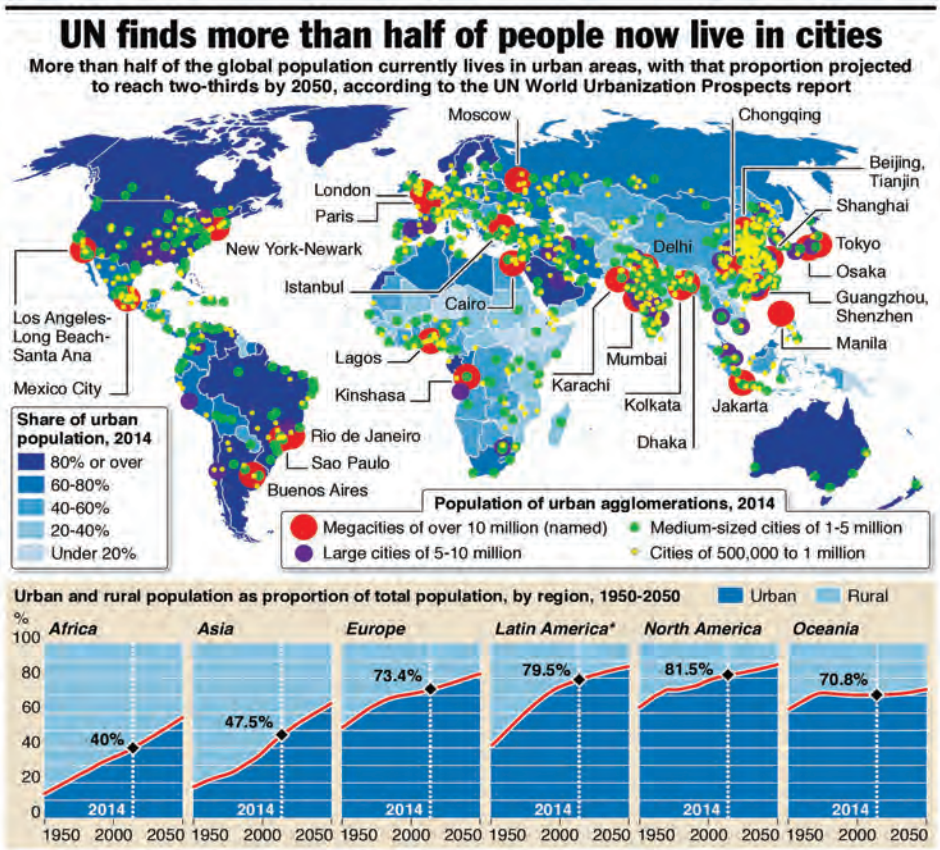


Fig. 6.21: Urbanisation in the World

Future Urbanization Trends

The world is rapidly urbanizing, with more and more people moving to cities. This trend is expected to continue in the coming decades, with profound implications for the way we live, work, and play.

- **Continued population growth:** According to the **World Bank**, the global urban population is expected to reach 6 billion by 2045. This is an increase by **1.5 times from** the 4.4 billion people who live in cities today.
  - This growth will be **concentrated in Africa and Asia,** with cities in these regions expected to see the fastest rates of expansion.
- **Rise of megacities:** The number of megacities – cities with over 10 million inhabitants – is expected to **double by 2030**.
  - These megacities will be home to a **significant portion of the world's urban population** and will present unique challenges in terms of infrastructure, housing, and governance.
- **Smart cities:** As cities become more crowded and complex, they will increasingly rely on technology to **improve efficiency and sustainability**.
  - Smart cities will use sensors, data analytics, and other technologies to optimize traffic flow, manage energy consumption, and provide essential services.
- **Vertical cities:** As land becomes scarce in cities, we will see a rise in vertical cities – **buildings with multiple layers** that can accommodate more people in a smaller footprint.
  - Vertical cities can help to **reduce urban sprawl and preserve green space**, but they also pose challenges in terms of design, construction, and social interaction.
- **Green cities:** As concerns about climate change grow, cities will increasingly focus on becoming more sustainable.
  - Green cities will **invest in renewable energy, green spaces, and public transportation** to reduce their environmental impact.

IGNITE YOUR MIND

Vertical Villages or Sprawl City?: As population density rises, what are the advantages and disadvantages of building "up" in vertical cities versus expanding outwards in urban sprawl?

Urban heat Islands

An Urban Heat Island (UHI) refers to a section of a city or metropolitan area where temperatures are notably higher than the surrounding countryside due to intensified human activity. This temperature difference is most noticeable during calm winds and at night, with the UHI effect being particularly pronounced during both summer and winter seasons.

Fig. 6.22: Urban Heat Islands across the World

Causes of UHI Formation: Several factors contribute to the formation of a UHI like:

- Dark surfaces, such as roads, pavements, and building roofs, absorb more solar heat and radiation, resulting in higher temperatures compared to suburban and rural areas.
- Urban materials like concrete and asphalt have different thermal properties, including heat capacity and thermal conductivity, which further exacerbate temperature differences between urban and rural areas.
- Geometric effects, like tall buildings providing multiple surfaces for reflection, can also contribute to the UHI effect.
- Waste heat from various sources such as automobiles, air conditioning, and industrial activities adds to the heat island effect.
- Factors like reduced vegetation, water bodies, and crop fields due to unplanned urban expansion and urbanization also play a role.

Impact of Urban Heat Island

Heat islands lead to elevated daytime temperatures, reduced nighttime cooling, and increased levels of air pollution. These conditions can result in heat-related deaths and illnesses, including respiratory difficulties, heat cramps, heat exhaustion, and non-fatal heat stroke.

Way Forward

- To address UHI effects, policymakers should prioritize measures to curb unplanned urban expansion by promoting opportunities in rural areas and implementing thoughtful urban planning for future growth.
- Additionally, planning strategies should incorporate passive cooling techniques and adequate ventilation systems.

With the growing threat of global warming, human intervention becomes imperative to ensure habitable environments. However, such interventions must be carefully planned and executed to be effective.

URBANIZATION IN INDIA

Urbanization refers to the **growth in the percentage** of a nation's populace residing in urban regions. It is measured by calculating the urban population as a percentage of the total population. The **growth of urban centers** and the emergence of new towns have been pivotal in driving urban population growth and urbanization in the country.

Status of Urbanisation in India

Cities in India are growing really fast, changing how the land looks and influencing the country's future. Even though there might not be one detailed report on how much India has urbanized, the **Ministry of Housing and Urban Affairs (MoHUA)** shares a lot of information through different reports and publications.

Annual Report 2021-22:

- **Urban Footprint:** Over 34% of India's population (461.1 million) resides in cities, projected to reach more than 50% by 2050.
- **City Boom:** The number of megacities with over 1 million inhabitants has skyrocketed from 35 in 2001 to 53 in 2011, showcasing rapid urban sprawl.
- **Infrastructure Push:** AMRUT has invested over ₹4.83 lakh crore in infrastructure projects across 500 cities, while the Smart Cities Mission has sanctioned projects worth over ₹2.05 lakh crore in 100 cities.
- **Housing for All:** Pradhan Mantri Awas Yojana (PMAY) has sanctioned over 1.13 crore houses in urban areas, aiming to achieve "Housing for All" by 2024.

Table: Trends of Urbanisation in India (1901-2011)

Year	Number of Towns/UAs	Urban Population (in Thousands)	% of Total Population	Decennial Growth (%)
1901	1.827	25.851.9	10.84	-
1911	1.815	25.941.6	10.29	0.35
1921	1,949	28,086.2	11.18	8.27
1931	2,072	33.456.0	11.99	19.12
1941	2.250	44.153.3	13.86	31.97
1951	2,843	62.443.7	17.29	41.42
1961	2,365	78.936.6	17.97	26.41
1971	2,590	1.09.114	19.91	38.23
1981	3.378	1.59.463	23.34	46.14
1991	4,689	2,17.611	25.71	36.47
2001	5.161	2.85.355	27.78	31.13
2011*	6.171	3.77.000	31.16	31.08

- In the past, urbanization in India mainly occurred in major cities. However, since 1991, the growth rates in these cities have slowed down, and faster urban growth is now observed in the surrounding districts.
  - For instance, greater Mumbai, India's most populous metropolis, experienced an annual growth rate of 0.4%, while Thane, located north of greater Mumbai, grew at a faster rate of 3.1% annually.

On a State Level

Urbanization trends in India vary considerably, but states with greater economic development generally experience a greater degree of urbanization.

- **Southern states, as well as Punjab, Haryana, Gujarat, Maharashtra, and West Bengal,** have urbanization rates higher than the national average.
- **Among smaller states,** Goa maintains its position at the top with the highest urbanization rate (62%) and then comes Mizoram (51.5%).
- In terms of major states, **Tamil Nadu** stands out with the highest urbanization rate of 48.4% in 2011.
- In contrast, states with **lower urbanisation rates** include Himachal Pradesh, which has the lowest rate at 10%, followed by Bihar at 11.3%, Assam at 14%, and Orissa at 16.6%. Additionally, states such as Uttar Pradesh, Rajasthan, Madhya Pradesh, Chhattisgarh, and Jharkhand also exhibit urbanization rates below the national average.

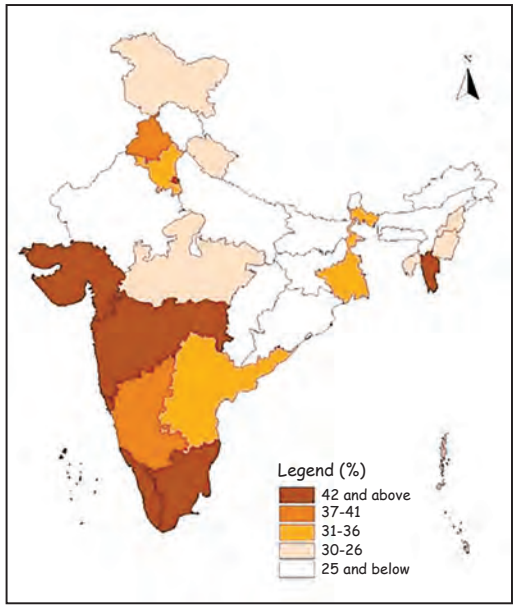


Fig. 6.23: Urbanisation Rate In India

Classification of cities in India

The Reserve Bank of India categorizes cities into Tier 1-6 based on their population size:

Tier	Population Range
Tier 1	1,00,000 and above
Tier 2	50,000 to 99,999
Tier 3	20,000 to 49,999
Tier 4	10,000 to 19,999

Tier 5	5,000 to 9,999
Tier 6	Less than 5,000

However, the above classification is not used in a daily sense and according to **Invest India,** they are defined as follows:

Tier-1: Thriving Urban Centres

These cities exemplify urban development, providing extensive opportunities and amenities. They are pivotal economic, commercial, and cultural centers, attracting attention on both national and international levels.

- These cities feature top-notch infrastructure, renowned educational institutions, and a variety of industries. Drawing diverse populations, they promote cultural diversity and innovation while offering ample employment prospects.
- These cities in India include Pune, Mumbai, Ahmedabad, Bengaluru, Chennai, Delhi, Kolkata, Hyderabad etc.

Tier-2: Emerging Urban Centres:

Tier II cities in India are rapidly growing and urbanizing, presenting promising development opportunities.

- Cities like Amritsar, Bhopal, Bhubaneswar, Chandigarh, Faridabad, Ghaziabad, Jamshedpur, Jaipur, Kochi, Lucknow, Nagpur, Patna, Raipur, Surat, Visakhapatnam, Agra, Ajmer, Kanpur, Mysuru, and Srinagar are witnessing significant economic and infrastructural advancements.
- They attract investments, support business growth, and offer diverse industries, educational institutions, and healthcare facilities to cater to their expanding populations.

Tier III: Growing Urban Centres

Rapid urbanization characterizes these cities, accompanied by progress in infrastructure, industry, and services. They present diverse opportunities across manufacturing, IT services, healthcare, education, and other sectors. Tier III cities are increasingly appealing for investment, contributing significantly to the economic development of their respective regions.

Tier IV Cities: Developing Urban Centres

Tier IV cities in India represent smaller urban centers and towns undergoing gradual growth and development. While they may have fewer amenities than higher-tier cities, they offer unique opportunities and contribute to the regional economy.

IGNITE YOUR MIND

Car-Centric Culture or Pedestrian Paradise?: As cities strive for sustainability, can we break car dependence and create walkable, bike-friendly spaces that prioritize human interaction and well-being?

Indian Mega Cities

India boasts six vibrant mega cities, each exceeding 10 million inhabitants and serving as economic and cultural hubs. Let's delve into their unique characteristics:

Delhi:

- **Capital City:** The political heart of India, home to the Parliament and government institutions.
- **Economic Powerhouse:** A major center for finance, IT, and services, contributing significantly to the national GDP.
- **Cultural Tapestry:** Rich history is reflected in Mughal monuments like Red Fort and Qutub Minar, alongside modern architectural marvels like Akshardham Temple.
- **Challenges:** Overcrowding, pollution, and traffic congestion pose significant challenges to urban living.

Mumbai

- **Financial Capital:** The "City of Dreams," known for its bustling financial markets and Bollywood film industry.
- **Port City:** Gateway to India's trade, with a thriving port and maritime sector.

Fig. 6.24: Indian Megacities

- **Cosmopolitan Hub:** Diverse population with a strong multicultural influence, evident in its cuisine, art, and architecture.
- **Challenges:** Housing affordability, social inequalities, and infrastructure limitations remain key concerns.

Bengaluru

- **IT Capital:** India's Silicon Valley, home to leading tech giants and a thriving startup ecosystem.
- **Education Hub:** Renowned universities and research institutions attract students and professionals from across the country.
- **Pleasant Climate:** Known as the "Garden City" for its greenery and relatively comfortable weather compared to other mega cities.
- **Challenges**: Rapid growth has led to traffic congestion, pollution, and rising cost of living.

Chennai

- **Cultural Capital of South India:** Rich heritage evident in its temples, museums, and Carnatic music scene.
- **Automobile Hub:** A major center for automobile manufacturing and related industries.
- **Educational City:** Renowned educational institutions attract students from across India and abroad.
- **Challenges:** Coastal location makes it vulnerable to natural disasters, and traffic congestion remains a concern.

Kolkata

- **Colonial Legacy:** Architectural marvels like the Victoria Memorial and Howrah Bridge reflect its colonial past.
- **Cultural Center:** Renowned for its art, literature, and intellectual traditions, including Nobel laureates Rabindranath Tagore and Amartya Sen.
- **Industrial Hub:** Significant presence of heavy industries like steel and jute manufacturing.
- **Challenges:** Ageing infrastructure, poverty, and air pollution require sustained attention.

Hyderabad (bold)

- **Imerging IT Hub:** Attracts professionals from across the country
- **Thriving Film Industry:** One of the largest fim industries in the world
- **Challenges:** Inadequate water supply, traffic problems and air pollution

IGNITE YOUR MIND

Global giants: Comparing the rise of major cities, Analyze the development of major global cities like London, New York, and Tokyo. What historical, cultural, and economic factors have shaped their unique characteristics?

The Future Trend of Urbanization In India.

Rising Tide of Urbanization

- **Numbers paint the picture:** By 2035, India's urban population is projected to reach a staggering 675 million, constituting nearly 43% of the total population. This translates to a rapid urbanization rate, surpassing even China's growth.
- **Shifting gears:** The trend is fueled by various factors like economic opportunities in cities, growing service sector, and increasing literacy rates, especially among youth. Additionally, mechanization in agriculture might push more people towards urban jobs.

Emerging Patterns

- **Beyond megacities:** While megacities like Mumbai and Delhi will continue to grow, the focus might shift towards developing smaller cities and tier-II towns. This is due to concerns about overcrowding and infrastructure strain in existing megacities.
- **Corridor development:** India might witness the rise of urban corridors connecting major cities, fostering economic integration and creating new urban centers.
- **Focus on sustainability:** The future of Indian cities likely emphasizes sustainable development, with investments in green infrastructure, smart city technologies, and efficient resource management.

Features of Indian Urbanisation

Urbanization in India is a distinctive and ever-changing phenomenon marked by the following features:

- **Rapid Urbanization:** India became the most populous country globally in 2023, leading to an unprecedented growth rate in its urban centers.
- **Informal Settlement Challenges:** A significant segment of the urban population resides in informal settlements or slums, characterized by inadequate infrastructure and services. These marginalized communities often operate outside formal systems.
- **Cultural and Modern Urban Coexistence**: Cities like Varanasi, Jaipur, and Haridwar boast a rich cultural heritage and historical significance, coexisting with the rapid development of modern urban hubs such as Mumbai, Bangalore, and Gurgaon.
- **Tertiary Sector-Driven Urbanization:** The growth of Indian cities is primarily attributed to advancements in the tertiary sector, encompassing communication, transport, services, and construction, rather than the secondary sector—a paradoxical trend.
- **Geographical Disparities**: Southern India exhibits higher levels of urbanization compared to Northern and Eastern regions, owing to historical, socio-cultural, and educational resources present in the southern part of the country.

Primate City and Related Terms

A primate city is one that stands out as the **uncontested largest and most influential city** within a country, region, or state. It typically **dwarfs other urban centers** in terms of population, economic power, cultural significance, and political influence.

Characteristics

- **Population dominance:** At least twice the population of the second-largest city in the country (some use a threshold of one-third of the national population).
- **Economic powerhouse:** Houses major financial institutions, corporations, and economic activities, significantly contributing to the national GDP.
- **Cultural hub:** Center of arts, media, fashion, education, and innovation, setting trends and attracting major events.
- **Political center:** Often the capital city or houses national government headquarters, wielding significant political influence.
- **Infrastructure and connectivity:** Well-developed infrastructure (transportation, communication) connecting it to other regions and the world.

Examples

- **London, UK:** Over 8 times the population of Birmingham, the second-largest city, and a global financial and cultural center.
- **Tokyo, Japan:** More than triple the population of Osaka and holds immense economic and cultural influence.

Notes: The existence and characteristics of primate cities **vary depending on a country's development** stage, history, and political structure. Some larger countries may have multiple significant urban centers **challenging the concept of a single dominant primate city**.

Related Terms

Gateway City

- A **major entry point for a country or region**, typically possessing a large international airport and seaport. Gateway cities **primarily function as hubs for** international trade, finance, and travel, facilitating the movement of people, goods, and capital across borders.
- **Key characteristics:** Strong international connectivity, significant logistics infrastructure, presence of multinational companies, often home to major immigration processing centers.
- **Examples:**
  - London, New York City, Dubai, Singapore, Amsterdam.
  - **In India**, Mumbai with a major airport and seaport, serves as India's financial and commercial hub, facilitating trade and attracting foreign investment.
  - **Delhi:** The national capital, Delhi, acts as a gateway for political and diplomatic connections, hosting embassies and international organizations.

World City

- A city with **significant global influence across various sectors**, including economics, culture, and politics. World cities house headquarters of multinational corporations, international organizations, and leading financial institutions, and exhibit a high degree of interconnectedness with other major cities worldwide.
- **Key characteristics:** Advanced economic activity, diverse cultural offerings, significant political influence, global reach of its businesses and institutions.
- **Examples:**
  - London, New York City, Tokyo, Paris, Hong Kong, Sao Paulo etc.
  - **Bangalore:** India's "Silicon Valley", Bangalore boasts a thriving IT industry with global reach and international recognition.

Alpha City

- A specific ranking within the top tier of world cities according to the Globalization and World Cities Research Network (GaWC). Alpha cities hold the most extensive global connections across key service sectors such as finance, law, and accounting.
- **Key characteristics:** Highest level of global interconnectedness, dominance in advanced service sectors, major concentration of corporate headquarters and international organizations.
- **Examples:**
  - Currently, only nine cities hold the **"Alpha ++" and "Alpha +"** rankings, including London, New York City, Paris, Tokyo, Hong Kong, Singapore, Shanghai, Beijing, Dubai.

Key Differences

- **Scope:** Gateway cities focus on international connections, while world cities have broader global influence. Alpha cities are a specific ranking within the category of world cities.
- **Function:** Gateway cities primarily facilitate entry and movement, while world cities have diverse functions across various sectors. Alpha cities tend to excel in advanced service sectors.
- **Specificity:** "Gateway city" is a descriptive term, while "world city" is a broader category and "Alpha city" is a specific ranking.

Issues Related To Urbanization

As the world's population increasingly gravitates towards cityscapes, urbanization stands as a powerful force shaping our future. While it fuels economic engines, fosters innovation, and concentrates opportunities, this rapid transformation also casts a long shadow of challenges that threaten the very fabric of urban life.

1. **Infrastructure Strain:** It refers to the **excessive pressure and challenges placed** on essential physical and organizational systems within a city.
    - As **urban areas expand and populations grow,** the demand for services such as housing, transportation, energy, water supply, and communication infrastructure increases.

Examples:

- **Global:** Rapid urban growth often outpaces infrastructure development, leading to shortages in housing, transportation, energy, and water.
- **India**:
    - **Housing**: Millions of people reside in slums or informal settlements, facing inadequate housing conditions (Source: "India's Urban Challenge" by World Bank).
    - **Water:** Chennai's water reservoirs often fall below 1% of capacity, leading to severe water scarcity and rationing (Source: "Megacity Water Woes: Chennai's Water Crisis" by Centre for Science and Environment).

2. **Environmental Degradation:** The concrete jungle often comes at the cost of the natural world. Air pollution chokes city lungs, with Beijing's smog-ridden skyline serving as a stark reminder. Urban waste mountains threaten ecosystems, while untreated sewage contaminates waterways.

Examples:

- **Global:** Urbanization contributes to air and water pollution, greenhouse gas emissions, and waste generation. A **2020 UN report** found that 99% of the world's urban population breathes polluted air exceeding WHO guidelines.
- **India:**
    - **Air Pollution:** Delhi's average PM2.5 levels regularly exceed 150 µg/m³, over 15 times the WHO safe limit, ranking it as the most polluted capital city globally.
    - **Water Pollution:** The Yamuna River, a primary water source for Delhi, receives approximately 3,296 million liters of untreated sewage daily, rendering it unfit for drinking or bathing (Source: Central Pollution Control Board).
    - **Land Subsidence:** Kolkata experiences a subsidence rate of up to 18 mm annually in certain areas, causing structural damage to buildings and infrastructure due to excessive groundwater extraction (Source: "Kolkata Sinking: Causes and Consequences" by Indian Institute of Technology Kharagpur).

3. **Social and Economic Inequalities:** The urban tapestry can be intricately woven, but its threads of opportunity are not always evenly distributed. Gentrification displaces vulnerable communities, pushing them into marginalized peripheries. Lack of access to education and healthcare widens the gap between the privileged and the underprivileged.

Examples:

- **Global:** Rapid urbanization can exacerbate existing inequalities, with **marginalized communities often lacking access to basic services** and facing higher risks of poverty and displacement. A 2019 UN Habitat report found that 1 billion people globally live in informal settlements.
- **India:**
    - **Informal Settlements:** Dharavi, one of Asia's largest slums, houses over 1 million people in a densely packed area of just 2.39 square kilometers, lacking basic amenities and infrastructure.
    - **Gentrification:** Displacement of low-income communities from central areas to peripheries is increasing as cities prioritize commercial development and upscale housing projects.
    - **Income Inequality:** Bengaluru's Gini coefficient, a measure of income inequality, stands at 0.62, indicating significant disparities between the rich and poor.

4. **Public Health Concerns:** Overcrowding in urban environments can be a breeding ground for disease. Infectious illnesses spread more easily, while mental health issues rise with the pressures of city life. Inadequate sanitation poses further risks, with millions globally lacking access to proper hygiene facilities.

Examples:

- **Global:** Overcrowding and poor sanitation in urban areas can lead to the spread of infectious diseases. A 2022 WHO report found that 3.4 billion people globally **lack access to safely managed sanitation.**
- **India:**
    - **Tuberculosis:** India has a TB incidence rate of 205 per 100,000 people, significantly higher than the global average of 54 per 1 Lakh Population, fueled by overcrowding and poor living conditions. (World Health Organization Global Tuberculosis Report 2023)
    - **Mental Health:** Mumbai has a prevalence rate of 15% for anxiety disorders and 12% for depressive disorders, reflecting the growing mental health burden in urban areas (Source: "Mental Health in Metropolitan Mumbai: Prevalence and Correlates" by Indian Journal of Psychiatry).
    - **Sanitation:** Over 20 million (as of 2021) urban residents in India lack access to toilets, leading to open defecation and increased risk of health hazards (Source: National Family Health Survey).

5. **Climate Change Vulnerability:** As the Earth's temperature rises, cities become frontline battlegrounds. Rising sea levels threaten coastal metropolises like Venice, Italy, while extreme weather events like floods and heatwaves pose additional risks.

Examples:

- **Global:** Coastal cities are particularly vulnerable to rising sea levels and extreme weather events. A **2023 IPCC report** estimates that up to 300 million people could be displaced due to coastal flooding by 2100.
- **India:**
  - **Sea Level Rise:** Chennai faces a potential sea level rise of up to 1 meter by 2100, threatening coastal infrastructure and livelihoods (Source: Intergovernmental Panel on Climate Change).
  - **Extreme Weather:** Floods and heatwaves are becoming more frequent and intense in Indian cities, causing economic losses and health impacts (Source: "India's Urban Climate Change Vulnerability Assessment" by Centre for Science and Environment).
  - **Dust Storms:** Delhi experiences around 8-10 dust storms annually, exacerbating air pollution and respiratory ailments (Source: "Dust Storms in Delhi: Causes and Mitigation Strategies" by The Energy and Resources Institute).

Case Study: Favelas of Brazil

Brazil's favelas, sprawling **informal settlements** perched on hillsides and tucked away in urban peripheries, present a complex case study of the realities and **challenges of rapid urbanization**. These vibrant yet often precarious communities offer a unique lens through which to explore themes of poverty, inequality, social resilience, and the struggle for inclusion in the formal fabric of the city.

Origins and Growth

- Favelas emerged in the early 20th century as **rural migrants** flocked to cities seeking **economic opportunities**, primarily fueled by industrialization.
- **Lack of affordable housing** and discriminatory policies pushed these migrants to occupy marginal lands, often steep hillsides or vacant areas, leading to the spontaneous growth of informal settlements.
- Today, over 13 million Brazilians live in favelas, with Rio de Janeiro alone boasting over 1 million residents in these **informal communities**.

Living Conditions and Challenges

- Favelas often face **inadequate infrastructure**, with limited access to clean water, sanitation, electricity, and waste management.
- **Housing typically consists of self-built** dwellings characterized by overcrowding, poor ventilation, and precarious construction.
- **Healthcare and education services** are often scarce or rudimentary, exacerbating social and economic inequalities.
- **Violence and crime** remain significant concerns, fueled by poverty, drug trafficking, and gang activity.

Community Resilience and Initiatives

- Despite the challenges, favelas display remarkable resilience and a vibrant community spirit.
- Residents have **created ingenious solution**s to overcome resource limitations, like rainwater harvesting, makeshift sanitation systems, and community centers.
- A thriving **informal economy** exists, with small businesses, street vendors, and micro-entrepreneurs contributing to local livelihoods.
- **Numerous grassroots organizations and NGOs work** within favelas to improve living conditions, advocate for residents' rights, and promote social development.

Global Significance

- The case of Brazilian favelas is **not unique**, with informal settlements existing in urban centers across the world.
- **Understanding the challenges** and resilience of these communities is crucial for informing urban planning policies, promoting social inclusion, and building sustainable and equitable cities in the face of rapid urbanization.

Differential Level of Air Pollution - Delhi, Kolkata And Mumbai

Differences in the severity of air pollution in Mumbai, Delhi, and Kolkata may be analysed by several factors, including geographical, meteorological, demographic, and economic elements. Key reasons for the higher air pollution levels in Delhi compared to Mumbai and Kolkata:

- **Geographical Location:** Delhi's geographical location, surrounded by the Aravalli hills and being landlocked, makes it prone to pollutant accumulation and hindered dispersion. In contrast, Mumbai's coastal location benefits from sea breezes that help disperse pollutants, while Kolkata's closeness to the Bay of Bengal aids ventilation and pollutant dispersion.

- **Meteorological conditions:** Delhi faces adverse meteorological conditions in winter, such as temperature inversions, which trap pollutants and lead to smog formation. Mumbai and Kolkata enjoy milder climates and favourable wind patterns that facilitate pollutant dispersion.
- **Population density and urbanisation:** Delhi experiences high population density and rapid urbanisation, resulting in increased vehicular traffic, industrial activities, and construction that contribute to pollution. Mumbai and Kolkata, though densely populated, may have more efficient and sustainable urban planning and transportation systems, reducing pollution.
- **Vehicular emissions**: Delhi has a notably high concentration of vehicles, including diesel vehicles that emit higher levels of particulate matter and nitrogen oxides. Mumbai and Kolkata rely more on public transportation, reducing private vehicle dependence.
- **Industrial activities**: Delhi hosts numerous industries within the city and nearby areas, leading to industrial emissions. Mumbai and Kolkata have industrial zones located farther from densely populated areas.
- **Agricultural practices:** Crop residue burning in neighbouring states significantly contributes to Delhi's air pollution during specific seasons. Mumbai and Kolkata are less affected by this agricultural practice.
- **Topography:** Delhi's flat topography impedes pollutant dispersion, especially during adverse weather conditions. The hilly terrain around Mumbai and Kolkata helps disperse pollutants more effectively.

Thus, addressing severe air pollution in Delhi requires a comprehensive approach, including improved urban planning, stricter emissions standards, enhanced public transportation, and regional collaboration to mitigate factors like crop residue burning in neighbouring states.

6. Urban Flooding

Urban flooding **differs significantly** from rural flooding due to urbanization leading to developed catchments.

- Developed catchments increase **flood peaks from 1.8 to 8 times** and flood volumes by up to 6 times.
- Urban flooding occurs rapidly, with **swift runoff** happening in minutes.
- Urban regions, **characterized** by high population densities, are prone to flooding, putting individuals in vulnerable zones at risk of casualties.
- The **aftermath of urban flooding** includes not only the immediate flooding impact but also the subsequent risk of infections, causing human distress, loss of income, and, in severe cases, fatalities.
- Unlike other flood types, urban flooding directly and promptly results from rainfall, making **forecasting challenging.**
- Urban flooding often **occurs with little warning** and in areas **not normally prone to flooding,** making it unpredictable and challenging to manage.

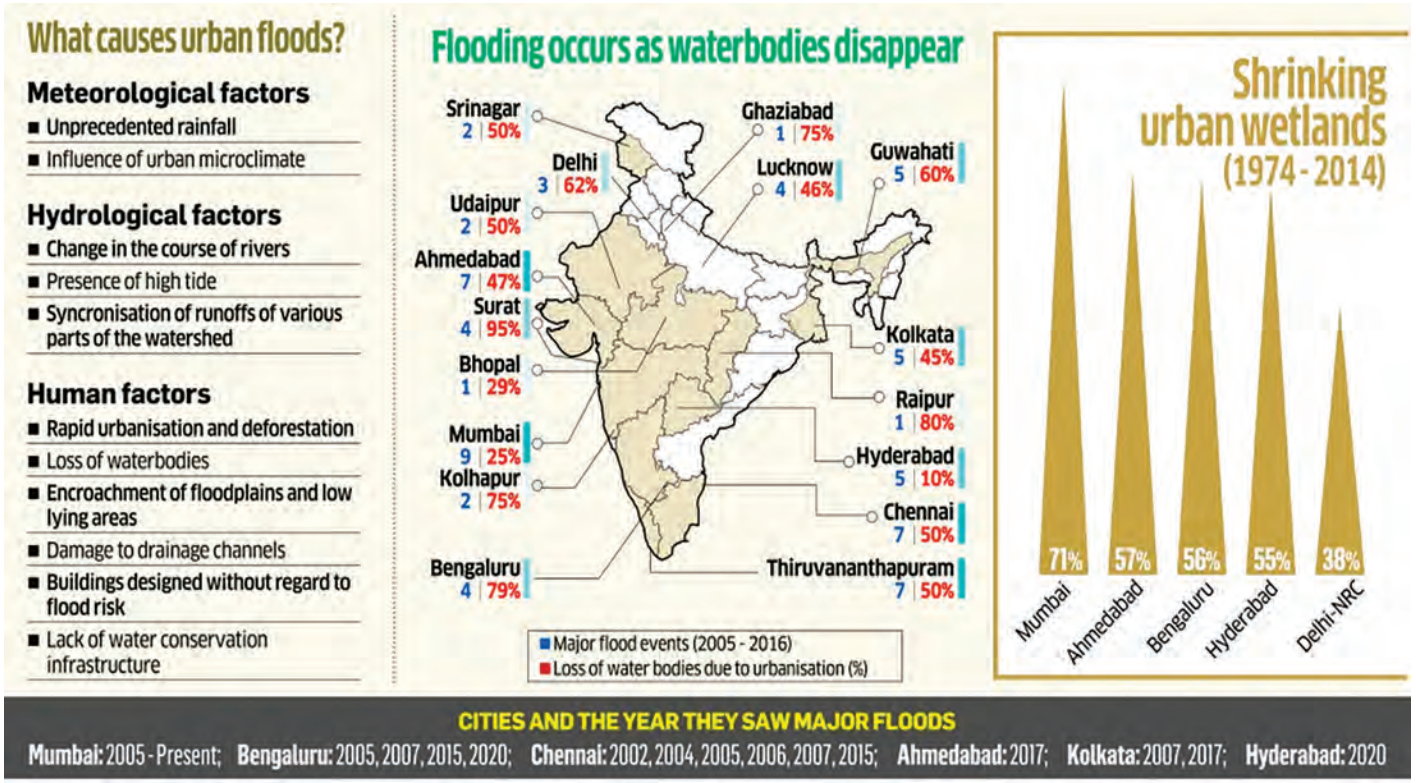

What causes urban floods?
Meteorological factors
Unprecedented rainfall
Influence of urban microclimate
Hydrological factors
Change in the course of rivers
Presence of high tide
Syncronisation of runoffs of various parts of the watershed
Human factors
Rapid urbanisation and deforestation
Loss of waterbodies
Encroachment of floodplains and low lying areas
Damage to drainage channels
Buildings designed without regard to flood risk
Lack of water conservation infrastructure
Flooding occurs as waterbodies disappear
Srinagar 2 | 50%
Ghaziabad 1 | 75%
Delhi 3 | 62%
Lucknow 4 | 46%
Guwahati 5 | 60%
Udaipur 2 | 50%
Ahmedabad 7 | 47%
Surat 4 | 95%
Kolkata 5 | 45%
Bhopal 1 | 29%
Raipur 1 | 80%
Mumbai 9 | 25%
Hyderabad 5 | 10%
Kolhapur 2 | 75%
Chennai 7 | 50%
Bengaluru 4 | 79%
Thiruvananthapuram 7 | 50%
Major flood events (2005 - 2016)
Loss of water bodies due to urbanisation (%)
Shrinking urban wetlands (1974 - 2014)
71%
57%
56%
55%
38%
Mumbai
Ahmedabad
Bengaluru
Hyderabad
Delhi-NRC
CITIES AND THE YEAR THEY SAW MAJOR FLOODS
Mumbai: 2005 - Present; Bengaluru: 2005, 2007, 2015, 2020; Chennai: 2002, 2004, 2005, 2006, 2007, 2015; Ahmedabad: 2017; Kolkata: 2007, 2017; Hyderabad: 2020

Fig. 6.25: Urban Floods

Anthropogenic Causes of Urban Flooding

Urbanization and Encroachment

- **Description**: Rapid urbanization leads to the conversion of natural drainage areas into concrete landscapes.
- **Impact**: Cities expanding into floodplains reduce the land's natural capacity to absorb excess rainfall, increasing runoff.

Inadequate Drainage Infrastructure

- **Description:** Many cities lack proper stormwater drainage systems, and existing systems may be poorly maintained or outdated.
- **Impact:** Deficient drainage infrastructure can result in waterlogging and flooding during heavy rainfall events.

Climate Change

- **Description:** Changing weather patterns, intensified monsoons, and extreme weather events associated with climate change.
- Impact: Increased rainfall and subsequent flooding in urban areas due to climate-induced factors.

Improper Waste Disposal

- **Description:** Blocked stormwater drains due to solid waste and garbage disposal in water channels.
- **Impact:** Exacerbates flooding problems in cities by hindering the natural flow of water through drainage systems.

Unchecked Construction

- **Description:** Unauthorized construction in low-lying areas or flood-prone zones.
- **Impact:** Worsens flooding by disrupting natural drainage patterns and increasing vulnerability to water-related disasters.

Lack of Green Spaces

- **Description**: Reduction of green spaces, such as parks and open areas.
- **Impact:** Limits the absorption of rainwater, contributing to flooding as the natural permeable surfaces are replaced by impermeable structures.

Natural Causes of Urban Flooding

Heavy Rainfall

- **Description:** Increased intensity and frequency due to climate change.
- **Impact:** Overwhelms drainage systems, and causes flash floods.

Topography

- **Description:** Low-lying areas or cities near rivers are more vulnerable.
- **Impact:** Increased risk of inundation and waterlogging.

Loss of Green Cover

- **Description:** Deforestation and reduction of natural drainage channels.
- **Impact:** Reduced water absorption, and increased runoff.

Remedial Measures:

- **Invest in drainage infrastructure:** Develop and maintain robust stormwater drainage systems capable of handling heavy rainfall. Implement modern technology like GIS (Geographical Information System) for better planning and management.
- **Floodplain zoning:** Strictly enforce zoning regulations to prevent construction in flood-prone areas, preserve and restore natural drainage systems, including wetlands and lakes.
- **Sustainable urban planning:** Emphasise sustainable urban planning practices, including the incorporation of green spaces and permeable surfaces to enhance water absorption.
- **Flood-resilient infrastructure:** Constructing infrastructure that can withstand flooding, such as elevated roads, buildings, and flood-resistant barriers.
- **Climate-resilient cities:** Developing comprehensive climate adaptation plans that consider future climate change impacts, including increased rainfall. Implementing resilient infrastructure and flood forecasting systems.
- **Collaboration**: Encourage collaboration between city authorities, environmental experts, and urban planners to develop holistic flood mitigation strategies.
- **Community participation:** Involve local communities in flood management and preparedness initiatives, including regular maintenance of stormwater drains.

Thus, Addressing flooding cities in India, including smart cities, requires a multi-pronged approach that involves infrastructure development, sustainable planning, climate adaptation, and active community participation. These lasting remedial measures are essential to reduce the impact of floods and create more resilient urban areas.

IGNITE YOUR MIND

Smart solutions for complex problems: From smart grids to intelligent traffic systems, technology is transforming cities. What are the potential benefits and risks of these innovations, and who gets to benefit most?

Chandigarh - A Model of Planned Urbanization

Chandigarh is a city located in the northern part of India and serves as the capital of two states, Punjab and Haryana. It is unique because it was the first planned city in post-independence India and was designed by the renowned architect Le Corbusier in the 1950s.

Key Features And Initiatives:

- **Master Plan:** Chandigarh was meticulously planned with a well-defined master plan that included a grid-like road network, designated sectors for various functions (residential, commercial, industrial, etc.), and a focus on green spaces and parks.
- **Sectoral Development:** The city is divided into well-organized sectors, each with its own markets, schools, healthcare facilities, and green spaces. This sector-wise planning enhances efficiency and accessibility.
- **Green And Open Spaces:** Chandigarh is known for its extensive green cover, with abundant parks and gardens integrated into the urban fabric. The city's commitment to preserving green spaces has contributed to its high livability index.
- **Sustainable Transportation**: The city emphasizes sustainable transportation with dedicated bicycle lanes, well-maintained public transportation vehicles, and a pedestrian-friendly layout.
- **Cultural And Educational Hubs:** Chandigarh boasts cultural centers, educational institutions, and government buildings that showcase innovative architectural design and planning.
- **Waste Management:** The city has implemented state-of-the-art methods for waste management systems to maintain cleanliness and hygiene.

Results And Impact

Chandigarh's well-planned urbanization has resulted in several positive outcomes:

- High quality of life with a focus on greenery and open spaces.
- Efficient transportation systems.
- A thriving cultural and educational hub.
- A clean and well-maintained urban environment.
- Economic growth and development opportunities.

Concept of Sustainable Urbanization

Sustainable urbanization refers to the **process of planning, developing, and managing** urban areas in a way that ensures they are environmentally, socially, and economically sustainable over the long term.

- It involves creating cities and towns that provide a **high quality of life** for residents while minimizing adverse effects on our environment and preserving resources for future generations.

Key Principles of Sustainable Urbanization

Environmental Sustainability

- Promotes practices such as energy efficiency, renewable energy use, waste reduction, and green infrastructure.
- Prioritizes clean air and water, biodiversity conservation, and climate resilience.

Social Inclusion

- Strives to create inclusive and accessible cities for all residents, irrespective of socio-economic background, age, gender, or abilities.
- Involves providing affordable housing, equitable access to services, and safe public spaces.

Economic Prosperity

- Promotes economic growth and innovation by attracting businesses, fostering entrepreneurship, and creating job opportunities.
- Supports diverse industries, including those related to sustainability and technology.

Efficient Transportation

- Prioritizes efficient and eco-friendly transportation modes like public transportation, bike lanes, and pedestrian-friendly streets.
- Aims to reduce traffic jams and pollution while enhancing ease of travel.

Resource Efficiency

- Focuses on efficient resource use, including water and energy conservation, waste reduction, and sustainable building practices.
- Promotes recycling and reuse to minimize waste generation.

Community Engagement

- Involves residents in decision-making processes to consider community needs and preferences during planning and development.

Fig. 6.26: Sustainable Urbanisation

Resilience

- Designs cities to withstand and recover from environmental challenges, including natural disasters and climate change.
- Incorporates resilience measures into infrastructure and land-use planning.

Cultural Preservation

- Values and preserves the cultural heritage and identity of the city's residents.
- Recognizes the importance of historical landmarks and traditions.

Good Governance

- Emphasizes effective governance and urban planning as critical for achieving sustainable urbanization.
- Transparent and accountable decision-making processes ensure alignment with sustainability goals.

Global Collaboration

- Acknowledges the interconnectedness of cities worldwide.
- Advocates for global collaboration and information sharing to address urban challenges and share best practices.

Sustainable urbanization requires **cooperation among governments, communities, businesses, and civil society. Aims** to create environmentally friendly, fair, and economically strong cities. Crucial for addressing **global challenges** such as climate change, population growth, and resource limitations.

IGNITE YOUR MIND

Greening the concrete jungle: How can we design cities that are more environmentally friendly and resilient to climate change? Explore concepts like green roofs, urban agriculture, and sustainable transportation.

Achieving sustainable urbanization requires a multi-pronged approach at both global and national levels. **Here are some key initiatives:**

Global Level

- **UN Sustainable Development Goals (SDGs):** Goal 11 specifically focuses on making cities and human settlements inclusive, safe, resilient, and sustainable. Initiatives under this goal include promoting compact, mixed-use urban development, investing in public transport, and improving air quality.
- **New Urban Agenda:** Adopted in 2016, this global framework for sustainable urbanization promotes equity, environmental sustainability, and economic prosperity in cities. Initiatives include participatory planning, inclusive housing, and disaster risk reduction.
- **C40 Cities Network:** A network of 96 megacities committed to addressing climate change. Initiatives include sharing best practices on renewable energy, green infrastructure, and sustainable transportation.
- **World Urban Forum:** A biennial event organized by UN-Habitat to discuss and showcase solutions for sustainable urban development.

National Level

- **Jawaharlal Nehru National Urban Renewal Mission (JNNURM):** Launched in 2005, JNNURM provides financial assistance to urban local bodies for infrastructure and service development.
- **National Urban Transport Policy (2006):** Promotes sustainable and equitable urban transportation, including public and non-motorized transport options.
- **National Urban Housing and Habitat Policy (2007):** Aims to offer affordable housing and enhance living conditions for urban residents, especially low-income groups.
- **Deendayal Antyodaya Yojana - National Urban Livelihoods Mission (DAY-NULM):** Launched in 2013, DAY-NULM aims to reduce poverty and vulnerability in urban poor households by providing skill development and self-employment opportunities.
- **Heritage City Development and Augmentation Yojana (HRIDAY):** Launched in 2015, HRIDAY aims to conserve and revitalize cultural heritage and tourism potential in 12 identified Indian cities.
- **Swachh Bharat Abhiyan:** Launched in 2014, this campaign targets improving sanitation and cleanliness in urban areas, including the construction of toilets and solid waste management.
- **Pradhan Mantri Awas Yojana (PMAY):** Launched in 2015, PMAY aims to provide affordable housing to urban residents, particularly for low-income groups and economically weaker sections.
- **Smart Cities Mission:** Launched in 2015, this mission aims to develop 100 smart cities in India, emphasizing sustainable and inclusive urban development.
- **Atal Mission for Rejuvenation and Urban Transformation (AMRUT):** Launched in 2015, AMRUT aims to enhance basic services and infrastructure in urban areas, including water supply and sewerage systems.

What is a Healthy City?

According to the World Health Organization (WHO), the criteria for a 'Healthy City' include:

- A clean and safe environment.
- Active community involvement in local governance.
- Fulfillment of basic needs for all residents.
- Easy access to healthcare services.

Overview of Urban Farming

- **Definition: Urban farming** involves the cultivation of food and raising of livestock within **urban environments**.
- **Forms:** Various methods include small backyard gardens, rooftop farms, vertical farms, and community gardens.
- **Purpose: Urban farming** serves multiple purposes, ranging from providing fresh food to fostering environmental sustainability and community building.

Benefits of Urban Farming

- **Fresh, Healthy Food:**
  - **Urban farms** produce fresh fruits, vegetables, herbs, meat, and dairy products.
  - Improves diets in cities with limited access to fresh produce.
- **Reduced Environmental Impact:**
  - Reduces the need for food transportation, lowering **greenhouse gas emissions**.
  - Improves soil quality and reduces **water pollution**.
- **Creation of Green Spaces:**
  - Enhances **air quality** and provides habitat for wildlife.
  - Aesthetically pleasing and offers recreational opportunities.
- **Economic Boost:**
  - Creates jobs and stimulates local economies.
  - Attracts tourists and visitors to **urban areas**.
- **Community Building:**
  - Brings people together to grow food and share resources.
  - Fosters a sense of community and shared responsibility.
- **Types of Urban Farming**
  - **Backyard Gardens:** Small private gardens grown in backyards or other private spaces.
  - **Community Gardens:** Gardens shared by a group of people, promoting communal cultivation.
  - **Rooftop Farms:** Farms situated on the roofs of buildings, utilizing vertical space.
  - **Vertical Farms:** Farms that grow food in vertically stacked layers, optimizing space.
  - **Aquaponics:** System combining fish farming with **hydroponics** (growing plants without soil).

Fig. 6.27: Types Of Urban Farming

Key Aspects of Urban Farming

- **Addressing Food Security:** Reduces reliance on distant agricultural sources, ensuring local food availability.
- **Innovative Techniques:**
  - Utilizes space-efficient methods like rooftop gardens and **aquaponics**.
  - Allows for year-round cultivation, irrespective of weather conditions.
- **Environmental Benefits:**
  - Minimizes the need for long-distance food transportation, reducing **carbon emissions**.
  - Contributes to improved **air quality**, biodiversity, and green spaces.
- **Community Engagement:**
  - Involves residents in the production of their food through community gardens and local markets.
  - Fosters a sense of connection, shared responsibility, and knowledge exchange.
- **Social and Economic Resilience:**
  - Creates local jobs, promotes entrepreneurship, and provides educational opportunities.
  - Enhances **food literacy** and encourages a healthier lifestyle with locally produced goods.

Urban farming offers a comprehensive solution to contemporary **urban challenges**, integrating agriculture into city landscapes. It promotes sustainability, strengthens community bonds, and contributes to a more resilient and environmentally conscious urban lifestyle.

IGNITE YOUR MIND

Urban Farming Revolution or Greenwashing Trend?: Can urban farming truly contribute to food security and provide fresh produce in dense urban environments, or is it a trendy fad with limited impact?

Government Initiatives on Urbanisation

Initiatives During Five-Year Plans

Urban development programs with a focus on poverty reduction have been integral to India's five-year plans since the inception of planned development. these programs include:

- **Integrated development of small and medium towns:** Launched in 1979-80, this program aimed to **enhance the economic status** and delivering fundamental services to small and medium-sized towns to curb the growth of major cities.
- **Low-Cost Sanitation Programme (LCS)**: Introduced in 1980-81 to accomplish the objective of **delivering sanitation** amenities to 80% of the urban populace, this program sought to eliminate manual scavenging by converting dry latrines.
- **Shelter and Sanitation for Pavement dwellers:** Targeting large urban areas with substantial homeless populations, this program aimed to provide shelter and sanitation facilities. Adequate subsidies for NGOs were crucial for its success.
- **Accelerated Urban Water Supply Programme:** A centrally sponsored scheme initiated during the eighth plan, **AUWSP focused** on providing water to towns with populations below 20,000 according to the 1991 census, with funding from the central government and state government.
- **National Slum Development Programme:** Started in 1996, the NSDP initiated the provision of central aid to state governments for enhancing slum conditions by providing amenities like water supply and sanitation.
- **Valmiki-Ambedkar Awas Yojana (VAMBAY):** Launched in 2001-02, VAMBAY aimed to provide shelter or upgrade existing housing for individuals residing in urban slums who are living in below poverty line groups. It was implemented in collaboration with state governments.

Recent Initiatives

Smart Cities Mission

- **Primary Aim:** Stimulate economic growth and enhance residents' well-being through local area development and leveraging technology for intelligent outcomes.
- **Approach:**
  - Retrofitting and redevelopment of existing areas, including slums, to improve overall livability.
  - Construction of new areas (Greenfields) adjacent to cities to accommodate urban population growth.

Fig. 6.28: Smart Cities Mission Development Strategy

- **Application of Smart Solutions**: Empower cities to use technology, information, and data to enhance infrastructure and services.
- **Holistic Development Strategy**:
  - Raise the quality of life, generate employment, and increase incomes for all residents.
  - Focus on marginalized and disadvantaged populations for inclusive urban environments.

IGNITE YOUR MIND

Smart Tech Salvation or Surveillance Society?: Can smart city technologies like facial recognition and AI-powered traffic management create a safer, more efficient city, or do they raise ethical concerns and potential for misuse?

Pradhan Mantri Awas Yojana-Urban (PMAY-U)

- **Initiative:** Pradhan Mantri Awas Yojana-Urban (PMAY-U)
- **Government Oversight:** Ministry of Housing and Urban Affairs (MoHUA)
- **Commencement Date**: June 25, 2015
- **Objective:** Address the shortage of urban housing, especially for Economically Weaker Sections (EWS), Lower-Income Groups (LIG), and Middle-Income Groups (MIG), including slum dwellers.
- **Primary Objective:** Ensure that all eligible urban households have access to a permanent dwelling, commonly referred to as a "Pucca House," by the year 2022, coinciding with India's 75th Independence Day.

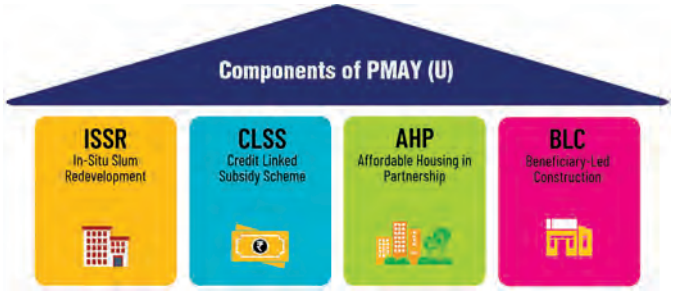


Fig. 6.29: Components of PMAY(U)

Swachh Bharat Mission - Urban (SBM - U)

- The program encompasses a **range of objectives**, including the elimination of open defecation, upgrading unsanitary toilets to pour flush toilets, eradicating manual scavenging, administering solid waste, and instilling a behavioral shift in people toward healthy sanitation practices.
- **SBM-U 2.0** has the vision to transform all cities into **'garbage free' zones** and implement effective grey and black water management in all cities, excluding those covered under AMRUT (Atal Mission For Rejuvenation And Urban Transformation).
- **Ongoing Initiatives:**
  - Declare all Urban Local Bodies (ULBs) as Open Defecation Free Plus (ODF+)
  - ULBs with populations below 1 lakh to be declared Open Defecation Free Double Plus (ODF++)
- **Focus Areas:**
  - Prioritize segregation of solid waste at its source
  - Utilize the 3Rs (Reduce, Reuse, Recycle) techniques
  - Adopt scientific methods for processing municipal solid waste
- Additionally, it will address the remediation of historical landfill sites to enhance solid waste management effectively. The budget allocated for SBM-U 2.0 spans approximately Rs 1.41 lakh crore, covering the period from 2021-22 to 2025-26.

Amrut (Atal Mission for Rejuvenation and Urban Transformation)

- **Initiative:** Atal Mission for Rejuvenation and Urban Transformation (AMRUT)
- **Commencement Date:** June 2015
- **Scope:** Dedicated to enhancing the quality of life for residents in 500 cities
- Core Objectives:
  - Provide households with accessible tap water and sewerage connections
  - Elevate urban amenities through the development of green spaces like parks
  - Curb pollution by promoting public transport and non-motorized options like walking and cycling
- **Emphasis on Quality of Life:** Focus on goals highly valued by citizens, especially women
- **Compliance Standards:** Adherence to established indicators and standards outlined by the Ministry of Housing and Urban Affairs (MoHUA) through Service Level Benchmarks (SLBs)

Amrut 2.0

- **Goals:** Achieve universal water supply coverage by extending household tap connections to all 4,378 statutory towns.
  - Attain complete coverage of household sewage in AMRUT cities.
- **Connection Targets:** Deliver nearly 2.67 crore tap connections and Provide 2.65 crore sewer/septage connections.
- **Innovative Elements:** Introduction of Pey Jal Survekshan to foster competition among cities in benchmarking urban water services.
- **Financial Mobilization:** Promote market finance by mandating 10% project implementation through Public-Private Partnerships (PPP) in cities with populations exceeding ten lakh.
- **Technology Integration:** Embrace cutting-edge global water technologies through the Technology Sub-Mission and Encourage entrepreneurial and startup involvement in the water ecosystem.

15th Finance Commission's Recommendations on Urbanization

The 2021-26 report from the 15th Finance Commission (FC) acknowledges urbanization as a significant driver of the country's economic growth and poverty reduction. It underscores the **importance of addressing upcoming challenges** related to urban expansion into metropolitan outskirts and the development of new planned cities.

Performance-Based Incubation Grants and Shared Services Centers

- A total recommended grant of Rs 4,36,361 Crore for Local Governments (LBs) for a period of 2021-26.
- Rs 8,000 Crore designated as performance-based incubation grants for eight new cities.
- Additional Rs 450 Crore allocated for Municipal Shared Services Centers.

Significant Increase in Direct Grants for Urban Local Bodies (ULBs)

- Recommended direct grant of Rs 1,21,055 Crore for ULBs.
- Represents a 39% increase compared to the 14th Finance Commission allocation of Rs 87,144 Crore.

Metropolitan Challenge Fund (MCF) for Diverse City Sizes

- Suggestion to establish Metropolitan Challenge Fund (MCF) of Rs 38,196 Crore.
- Intended for Category-I cities with populations exceeding 50 million, excluding Chandigarh, Delhi, and Srinagar.

- 32% of MCF is allocated for improving air quality, while 68% is designated for achieving service level benchmarks in water supply, rainwater harvesting, water recycling, solid waste management, and sanitation.

Allocation for Category-II Cities

- Total allocation of Rs 82,859 Crore for Category-II cities, excluding those with populations exceeding one million.
- 40% of funds are flexible for locally identified priorities.
- 60% of funds are tied to achieving national priority goals in drinking water, rainwater harvesting, solid waste management, and sanitation.

Thus, FC has duly recognised the role of urbanisation in national economic development with a specific focus on air quality, water and sanitation, health emergencies (diagnostic infrastructure), initiating the development of new towns as a pilot project, along with the establishment of shared data centers, cities and towns, as human settlements, exhibit significant economic, social, and cultural diversity. However, many Indian cities face various challenges. To address these issues and ensure cities are habitable, clean, safe, and healthy for current and future generations, effective urban planning is essential.

Role of NITI Aayog in Urban Planning

NITI Aayog plays a multifaceted role in shaping the future of urban planning in India. Its key functions:

- **Think tank and advisor:** NITI Aayog acts as a think tank, formulating policies and providing **strategic advice to the government** on urban development and infrastructure.
  - It analyzes and comments on various urban sector schemes, programs, and projects to ensure their effectiveness and alignment with national goals.

Objectives of #NITIaayog
fostering COOPERATIVE FEDERALISM, active involvement of states
formulation of plans at VILLAGE-level, aggregation at higher levels
SPECIAL ATTENTION to sections at risk of not benefitting adequately from economic progress
economic policy that incorporates NATIONAL SECURITY INTERESTS
feedback for constant INNOVATIVE IMPROVEMENTS
partnerships with national and international THINK TANKS
creating a KNOWLEDGE, INNOVATION & ENTREPRENEURIAL support system
platform for RESOLUTION of inter-sectoral & inter-departmental issues
state-of-the-art resource center for RESEARCH on good governance
focus on TECHNOLOGY upgradation and CAPACITY BUILDING
Source: PIB.NIC.IN

Fig. 6.30: Composition and Objectives of NITI Aayog

- **Guiding vision documents:** NITI Aayog prepares crucial documents like the **India Vision 2030,** which outlines a long-term vision for sustainable urban development and provides a framework for state and local governments.
- **Formulation of national urban development strategies:** NITI Aayog actively participates in shaping national urban policies and programs like the **Smart Cities Mission and AMRUT (Atal Mission for Rejuvenation and Urban Transformation)**.

Specific Initiatives

- **Managing Urbanisation (MU) Division:** This dedicated division within NITI Aayog focuses on providing data-driven policy inputs for sustainable and inclusive urban development.
- **Reforms in Urban Planning Capacity:** NITI Aayog has undertaken a comprehensive initiative to enhance the capacity of urban planning professionals and institutions across the country.
- **India Urban Futures Initiative:** This initiative aims to develop long-term urban development strategies for India's major cities.

In conclusion, India's planning journey began with **socialist ideals**, spearheaded by the Planning Commission. Now, NITI Aayog ushers in a new era of **"Bottom-Up" planning and "Cooperative Federalism,"** emphasizing collaboration and local empowerment. This shift signals a promising evolution towards **achieving socio-economic well-being** for all.

TOWN PLANNING

Town planning, also known as **urban planning**, is the process of shaping the development and growth of towns and cities. It encompasses a wide range of considerations, from land use and zoning to infrastructure development, transportation systems, and public spaces.

Principles of Urban Planning

- **Urban Decentralization:** This involves encouraging the establishment of industries and residential areas in suburban towns to alleviate overcrowding in large metropolitan cities.
- **Garden suburbs and garden cities:** Developing gardens and green belts is crucial to providing cities with a clean and healthy environment.
- **New Towns:** This principle advocates for the creation of planned towns outside the city's municipal limits, equipped with essential urban facilities to attract industrial and business activities. Examples in India include New Delhi, Chandigarh, and Gandhinagar.
- **Expanded Towns:** These towns draw workers, artisans, businessmen, and industrialists from neighbouring cities, helping alleviate population burdens.
- **Urban Renewal:** Urban planning involves the development of master plans spanning 10 or 20 years to improve land use patterns and infrastructure in older cities.
- **Slum clearance:** Strategies for improving urban slums include either relocating residents to new planned colonies free of cost or providing basic amenities in existing slums, such as drinking water, electricity, garbage disposal, sewerage, and roads.
- **Rehabilitation versus redevelopment:** This principle aims to enhance housing conditions in old cities, whether through renovating existing buildings or constructing new ones after demolishing old structures.
- **Traffic Segregation:** To enhance urban traffic flow, this principle offers solutions like road widening, flyovers, subways, bridges, metros, underground railways, and parking facilities.
- **City Centre development:** Focusing on improving the central business district is essential to maintain a vibrant urban core.

Necessity of Town Planning

Towns and cities grow organically, but without proper planning, this growth can lead to chaos and challenges. Town planning aims to address these issues by:

- **Promoting efficient land use:** Zoning regulations ensure compatible land uses, separating residential areas from industrial zones.
  - **Copenhagen, Denmark:** The city's Five Finger Plan separates residential areas with green fingers reaching into the city center, promoting walkability and access to nature.
  - **Chandigarh, India**: This planned city is divided into sectors dedicated to specific functions like housing, commerce, and education, ensuring efficient resource allocation and preventing sprawl.
- **Creating sustainable transportation systems:** Public transportation networks, pedestrian walkways, and cycling infrastructure reduce reliance on cars and promote healthier lifestyles.

Examples:

- **Amsterdam, Netherlands**: The city prioritizes cycling with extensive dedicated lanes, making it one of the world's most bicycle-friendly cities.
- **Kochi, Kerala:** The city's integrated water metro system is a prime example of sustainable transportation solutions. It utilizes existing waterways to connect various parts of the city, reducing traffic congestion and promoting eco-friendly travel.

- **Developing green spaces:** Parks, gardens, and urban forests mitigate the urban heat island effect, improve air quality, and provide recreational opportunities.
  - **Singapore:** Known as the "Garden City," Singapore boasts numerous parks and gardens integrated into its urban fabric, offering residents respite and improving air quality.
  - **Mysuru, Karnataka:** Known as the "Garden City of Karnataka," Mysuru boasts numerous parks and gardens like Brindavan Gardens and Lalbagh Botanical Garden. These green spaces contribute to air quality, provide recreational opportunities, and enhance the city's aesthetic appeal.
- **Fostering community engagement:** Inclusive planning processes ensure that the needs and aspirations of residents are heard and reflected in town development.

Examples:

- **Freiburg, Germany:** Extensive resident participation in planning decisions led to the development of Vauban, a sustainable neighborhood known for its car-free design and community spirit.
- **Surat, Gujarat:** Surat's success in waste management and sanitation owes much to community engagement. Citizen awareness campaigns and initiatives like waste segregation programs have contributed to significant improvements in the city's cleanliness.

Town Planning in India

Town planning in India is a multifaceted story, marked by significant achievements, ongoing challenges, and continuous adaptation. Here's a comprehensive overview:

Key Features

- **Legal Framework:** The Town and Country Planning Act of 1951 provides the legal framework for town planning

across states, empowering them to establish planning authorities and formulate development plans.

- **Master Plans:** Cities and towns have Master Plans outlining long-term development visions, land use regulations, infrastructure requirements, and environmental considerations.
- **Decentralization and Participation:** Increasing emphasis on involving local communities in planning processes through public hearings, participatory budgeting, and citizen groups.
- **Sustainable Development:** Growing focus on incorporating environmental sustainability principles into planning, promoting green spaces, renewable energy, and efficient resource management.
- **Technological Advancements:** The Smart Cities Mission aims to leverage technology for improved governance, infrastructure management, and service delivery in 100 cities.

Town Planning in The Post-Independence Period

Following independence in 1947, India embarked on a journey of urban development, with town planning playing a crucial role in shaping the country's evolving urban landscape.

Here's a decade-by-decade glimpse into this fascinating journey, highlighting key initiatives and impactful examples:

1950s - Laying the Foundation

- **Town and Country Planning Act, 1951:** This act established the legal framework for town planning across India, empowering states to create planning authorities and formulate development plans.
- **Chandigarh:** This planned city designed by Le Corbusier became a benchmark for modern town planning, showcasing efficient land use, integrated infrastructure, and green spaces.

1960s & 70s - Focus on Industrialization

- **Development of industrial townships:** Cities like Bhilai and Bokaro were planned around steel plants, fostering economic growth but often neglecting social and environmental considerations.
- **Master Plans for Metropolitan Cities:** Comprehensive plans were developed for cities like Delhi and Mumbai, aiming to manage urban expansion and infrastructure needs.

1980s & 90s - Addressing Challenges and Reforms

- **Emergence of environmental concerns:** Issues like air pollution and water scarcity led to a greater focus on environmental sustainability in town planning.
- **Decentralization and participation:** Efforts were made to involve local communities in planning processes, recognizing the importance of citizen participation.
- **Slum improvement initiatives:** Programs like Nehru Rozgar Yojana (NRY) aimed to upgrade living conditions in slums by providing basic amenities and infrastructure.

2000s & 2010s - New Era of Urban Development

- **Jawaharlal Nehru National Urban Renewal Mission (JNNURM, 2005-2013):** This mission focused on holistic development of cities, including infrastructure, governance, and social amenities.
- **Focus on public spaces and walkability:** Urban design principles promoting pedestrian-friendly spaces and interconnectedness gained prominence.

Achievements

- **Planned Cities:** Chandigarh stands as a pioneering example of planned urban development, showcasing efficient land use and integrated infrastructure.
- **Improved Infrastructure:** Initiatives like JNNURM and Smart Cities Mission have led to significant improvements in infrastructure across various cities.
- **Slum Improvement:** Programs like Pradhan Mantri Awas Yojana (PMAY) aim to address the challenge of urban slums by providing affordable housing and improving living conditions.
- **Public Spaces:** Increasing focus on creating pedestrian-friendly public spaces and promoting walkability in cities.

IMPORTANT TERMS RELATED TO URBAN PLANNING

Urban Agglomeration

An urban agglomeration is a **densely populated** area consisting of a city and its surrounding suburbs and exurbs. It's essentially a metropolitan area, characterized by a high concentration of people, businesses, industries, and infrastructure. These agglomerations are **found worldwide**, in both developed and developing nations.

Key Features of Urban Agglomerations

- Densely packed population
- Concentration of businesses and industries
- Diverse populace
- Extensive infrastructure network
- Complex social and economic systems

Example

Global: Tokyo holds the title of the **most populous urban agglomeration globally**, boasting over 37 million residents. It's a center for commerce, finance, and culture, housing numerous Fortune Global 500 companies and being a popular tourist destination.

India: Delhi ranks second in terms of population among Indian urban agglomerations, with over 25 million inhabitants. It serves as the nation's capital and is a major hub for government, politics, and commerce. Delhi is rich in historical and cultural attractions, including the Red Fort and Jama Masjid.

Urban Fringe

The urban fringe marks the **transition zone** between the urban core and the rural hinterland. It typically features a blend of land uses, encompassing residential, commercial, and industrial areas. This zone has witnessed a **surge in population** as individuals seek to reside outside the city center while maintaining proximity to amenities and job opportunities.

Characteristics of the Urban Fringe

- Lower population density compared to the urban core
- Mixed land-use patterns
- Rapidly growing population
- Often faces challenges with transportation

Example

Global: The outskirts of Tokyo, Japan, have a rural-urban fringe that is dominated by commercial and industrial land uses.

Suburbanisation

Suburbanisation refers to the trend of people **relocating from the city center to the suburbs**. This phenomenon is driven by several factors, including the desire for more affordable housing, spacious living environments, and a safer atmosphere. Suburbanisation has significantly impacted the development of cities across the globe.

Characteristics of Suburbanisation

- Outward migration from the city center
- Growth of suburban areas
- Transformations in land use patterns
- Increased traffic congestion

Example

Global: The 1950s witnessed a major demographic shift in the **United States**, with millions opting to move from the city center to the suburbs. This trend was fueled by various factors, such as the availability of inexpensive land, the rise of the automobile industry, and government policies supporting single-family home construction.

India: Mumbai's recent economic boom has triggered its suburbanisation. As the city's prosperity has increased, more residents can now afford suburban living. This has led to the development of new townships and the expansion of existing ones.

Gentrification

Gentrification is the process of **renovating and upgrading** a working-class or lower-income neighborhood, often resulting in the displacement of its original residents. This phenomenon is typically **driven by the influx of wealthier residents,** who are drawn to the area's historical buildings, proximity to amenities, and potential for property appreciation.

Characteristics of Gentrification

- Displacement of lower-income residents
- Rising property values
- Transformations in the neighborhood's character
- Increased investment

Example

Global: Brooklyn, New York: Once a working-class industrial area, Brooklyn has witnessed extensive gentrification in recent decades. Wealthy residents have been drawn to its historical brownstones, vibrant artistic scene, and proximity to Manhattan. This has led to **rising property values**, the displacement of some longtime residents, and the emergence of trendy cafes, boutiques, and art galleries.

India: Hauz Khas Village, Delhi: Formerly an artisan community, Hauz Khas Village has transformed into a trendy neighborhood popular with young professionals and tourists. The restoration of historical buildings, the **establishment of upscale restaurants and bars**, and the presence of art galleries have contributed to its gentrification. However, **concerns** have been raised about the displacement of traditional artisans and the rising cost of living.

IGNITE YOUR MIND

Globalized Gentrification or Community Revitalization? As investments flow into previously undervalued inner-city areas, does it empower local residents or displace them, creating "Disneyfied" spaces disconnected from their cultural roots?

Brownfields

Brownfields are essentially **vacant or underutilized properties** that have been **impacted by previous industrial or commercial activities**. These activities could have ranged from manufacturing and mining to fuel storage and waste disposal, leaving behind contaminants like chemicals, heavy metals, or petroleum in the soil and groundwater.

Characteristics of Brownfields

- **Environmental contamination:** The presence of pollutants necessitates careful assessment and remediation efforts before redevelopment.
- **Location potential:** Often situated in strategic urban areas, brownfields offer prime real estate opportunities for revitalization.
- **Infrastructure advantage:** Existing infrastructure, like roads and utilities, can be leveraged for redevelopment projects.
- **Community concerns:** Public perception of potential health risks and stigma associated with contamination need to be addressed.

Example

Global: Docks Waterfront, London: This once-derelict dockland area in London has been transformed into a thriving mixed-use development. The project involved extensive environmental cleanup, preserving historical structures, and creating residential apartments, offices, parks, and cultural venues.

India: Sewri Landfill, Mumbai: This former landfill in Mumbai is undergoing a remarkable transformation into a public park and recreational area. The project involves capping the landfill to prevent contamination, planting trees, and creating walking and cycling paths.

SLUMS IN INDIA

Slums in India refer to **informal settlements** or impoverished urban areas characterized by inadequate housing, overcrowding, poor sanitation, and limited access to basic services such as clean water, healthcare, and education. The **largest slum** in India is Dharavi in Mumbai.

Characteristics of Slums

- **Due to limited space,** slums are densely populated, with multiple families often sharing small living spaces.
- Slum dwellings often **consist of** makeshift structures constructed from materials like corrugated metal, cardboard, or tarpaulin. These homes lack proper ventilation and are prone to flooding and other hazards.
- Slums are often **located** in hazardous areas, such as floodplains and garbage dumps. This makes people living in slums more vulnerable to natural disasters and diseases.
- **Children** residing in slum areas are **more vulnerable** to malnourishment and dropping out of school.
- **Women** living in slums are more prone to be **victims of violence** and exploitation.
- Many slum residents work in the **informal sector,** with irregular and low-income jobs, making it challenging to escape poverty.

Status of Slums in India

- **Nine states have higher slum populations** than the national average. Andhra Pradesh tops the list, with 12.04% of its urban population living in slums. **Other States** Are: Chhattisgarh, Madhya Pradesh, Maharashtra, Odisha, West Bengal, Sikkim, Jammu & Kashmir And Haryana.
- **India has 2,613 towns with slums**. Of these, 57 per cent are in Tamil Nadu, Madhya Pradesh, Uttar Pradesh, Karnataka And Maharashtra.
- Out of the Indian slum households **lacking proper drainage**, 44% rely on open drains, and nearly 19% have no drainage connection, accounting for 63% in total.
- **Three Southern States** are home to 39% of slum households in India depending on untreated water for drinking. **Most of them are in Tamil Nadu**.

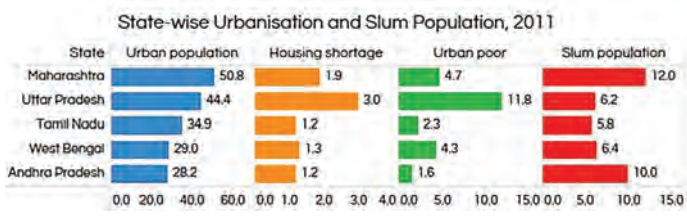


Fig. 6.31: State-wise Urbanisation and Slum Population (in million)

Slum Redevelopment

State Governments are responsible for the advancement of slums while the Centre's **'Pradhan Mantri Awas Yojna (urban)'** scheme addresses slum redevelopment under its component **"In-Situ Slum Redevelopment (ISSR)"** which has the following provisions:

- **All houses constructed** for eligible slum residents through the ISSR component involving private developers are entitled to receive Rs. 1 lakh per house in central assistance.
- **Following redevelopment**, it is suggested that the state/UT government should consider de-notifying the slum areas in accordance with the provided guidelines.
- States and cities have the flexibility to utilize this central assistance for the redevelopment of other slum areas.

Dharavi

Dharavi stands as the **largest slum cluster in Asia**, spanning around 300 hectares of valuable land in proximity to the upscale **Bandra-Kurla Complex (BKC) area**.

- Dharavi evolved into an **informal settlement** following its establishment in 1882.
- Hosting approximately 58,000 families, predominantly **comprising migrants**, Dharavi also accommodates **small business enterprises**.
- The need for Dharavi's redevelopment arises from **substandard living conditions** and the haphazard expansion of urban areas.

Dharavi Redevelopment Project

- The redevelopment plan encompasses an **integrated approach covering** residential, commercial, and industrial development, boasting a floor space index exceeding 4.

- The **Dharavi Redevelopment Authority,** established under the Slum Redevelopment Authority (SRA) in 2004, originated from an initial proposal in 1999.
- Despite numerous global tenders in the past, the **project failed to materialize**.
- **Finally, in November 2022,** Adani Properties Private Limited secured the 259-hectare redevelopment project through competitive bidding.

Recent Controversy

- There are concerns raised about the **Transferable Development Rights** notification.
  - **Transferable Development Rights (TDR)** allow property owners to transfer the development potential (such as the right to build additional floors or units) from one parcel of land to another.

Current Status of Project

- The formation of **Dharavi Redevelopment Project Pvt Ltd (DRPPL)** as a **special purpose vehicle (SPV)** involved an 80% stake from the developer and a 20% stake from the state government.
- The anticipated completion time for the project is 7-10 years from the commencement scheduled for the following year.

Way Forward

- **Comprehensive Development Approach:**
  - Beyond constructing housing, prioritize promoting livelihoods and enhancing social and economic infrastructure for slum dwellers' holistic development.
- **Housing and Population Policies:**
  - Establish housing and population policies, centered on housing rights and the right to a clean environment, for effective urban planning at all levels.
  - Ensure these policies are geared towards fostering inclusive cities and poverty alleviation.
- **Addressing Future Challenges:**
  - Emphasize income generation, transport improvements, and beneficiary empowerment to proactively tackle potential future issues in urban planning.

Three-Pronged Strategy for Slum-Free Cities

1. **Granting Clear, Free Titles:** Provide residents with clear, free titles to confer property privileges and transform property into a tangible asset.
2. **Infrastructure and Services Upgrade:** Enhance infrastructure and services, including water, power, sewage connections, solid waste management, street lighting, and neighborhood security with police support.
3. **High-Density, Low-Income Zoning:** Implement zoning policies that allow individual property owners in high-density, low-income areas to upgrade their homes without risk and rent out properties to formal commercial establishments.

In conclusion, settlements and urbanization represent **dynamic facets** of human habitation, reflecting societal evolution and economic development. The **continuous expansion** of urban settlements poses both opportunities and challenges, necessitating sustainable planning and infrastructure. Balancing the preservation of cultural heritage with modern development is crucial for fostering **resilient and inclusive cities**. As urbanization accelerates globally, addressing issues of equitable access to resources, environmental sustainability, and community engagement becomes paramount for creating livable and vibrant urban spaces. A **holistic approach,** incorporating technological advancements and social inclusivity, is essential to guide the future trajectory of settlements and urban development. **We should be guided by not just the provision of urban amenities in rural areas, but equally be determined about provision of urban amenities in rural areas.**

Regional Planning & Human Development

7

Introduction

The term **'planning'** is commonly used in everyday language, often in the context of preparing for exams or trips. In the realm of economic development, planning involves a comprehensive process of thinking, creating a scheme, and executing actions to achieve specific goals. This chapter focuses on planning in the context of economic development, distinguishing it from haphazard methods of reform and reconstruction. There are two primary approaches to planning: **Sectoral Planning**, which targets specific economic sectors, and **Regional Planning,** which aims to address spatial disparities in development by strategically reducing regional imbalances. The latter is essential due to the uneven economic development observed across different areas within a country.

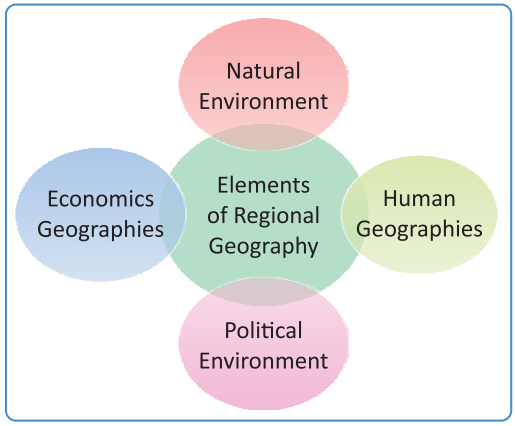


Fig. 7.1: Elements of Regional Geography

Regional Geography

Regional geography is a branch of geography that studies the world's regions, which are areas of land that have common features that distinguish them from other areas. Regional geography has a long history and has evolved over time in response to different theoretical and practical challenges.

Concept of Region

Geography and Regions:

In the field of geography, regions are expanses broadly categorized by their physical characteristics **(physical geography),** the impact of human activities **(human geography),** and the intricate interplay between humanity and the environment **(environmental geography).**

Region as Defined by Several Geographers:

- "The Region is an area of the Earth Surface." -Taylor
- "A region is a domain where many dissimilar things are artificially brought together have subsequently adopted themselves to a common existence." - Vidal-de-La-Blache.
- "A region is a specific area that is distinct from other areas and extends as far as its distinction extends."- Richard Hartshorne
- "A region is a complex of land, water, air, plant, animal and man, regarded under their spatial relationship as together constituting a definite portion of the earth surface." - A.J. Herbertson

Examples of Regions:

- **Physical Regions:** These are regions that share similar natural features, such as climate, landforms, vegetation, or wildlife. For example, the **Himalayan** region is a physical region that covers the northern part of India and has a cold and mountainous climate, rugged terrain, and rich biodiversity.
- **Cultural regions:** These are regions that share similar human characteristics, such as language, religion, ethnicity, or history. For example, the **Hindi** Belt is a cultural region that includes states in north-central India that speak Hindi or related languages and have a common cultural and historical heritage.
- **Economic regions:** These are regions that share similar patterns of production, trade, or consumption. For example, the **Golden Quadrilateral** is an economic region that connects four major cities of India (Delhi, Mumbai, Chennai, and Kolkata) by a network of highways and railways and facilitates the movement of goods and services.
- **Political regions:** These are regions that share similar forms of government, laws, or institutions. For example, the **Union Territories** are political regions that are directly administered by the central government of India and have different constitutional and administrative arrangements than the states.
- **Environmental regions:** These are regions that share similar ecological conditions, problems, or solutions. For example, the **Western Ghats.**

Characteristics of a Region

- **Spatial Delimitation:** A region has defined spatial boundaries that separate it from neighboring areas. These boundaries can be physical, political, cultural, or economic.
- **Homogeneity and Heterogeneity:** Regions exhibit a level of internal homogeneity in certain aspects, whether cultural, economic, or environmental. They also show heterogeneity, or diversity, particularly toward their boundaries.
- **Distinctive Identity:** Each region possesses a unique identity shaped by its history, culture, and physical characteristics.
- **Functional Interdependence:** Regions are interconnected through functional relationships, such as economic, social, or environmental interactions.
- **Dynamic Nature:** Regions are not static; they undergo changes over time. This dynamism can be seen in social, economic, and environmental aspects.
- **Hierarchical Organization:** Regions often exhibit hierarchical arrangements, where certain features or characteristics have homogeneity at larger scales but more variation at smaller scales.
- **Purposeful Delimitation:** Regions are often delineated for specific purposes, such as administrative, economic planning, or cultural categorization.
- **Resource Endowment:** Regions may have specific resources—natural, human, or economic—that contribute to their uniqueness or play a crucial role in regional planning.
- **Core-Periphery Structure:** Many regions have a core-periphery structure, where the core represents a more developed or influential area, while the periphery may be less developed.
- **Cultural and Environmental Patterns:** Regions may be defined by common cultural traits, language, traditions, as well as shared environmental characteristics like climate and vegetation.
- **Scale and Size Variability:** Regions can vary in scale, ranging from local or micro-level regions to larger macro-level regions.
- **Interaction with Surrounding Areas:** Regions interact with and may be influenced by neighboring regions, contributing to a broader regional context.

IGNITE YOUR MIND

Beyond Borders: Is the concept of "region" still relevant in a globalized world with interconnected economies and societies? How can regional planning adapt to these changing dynamics?

Structure of a Region

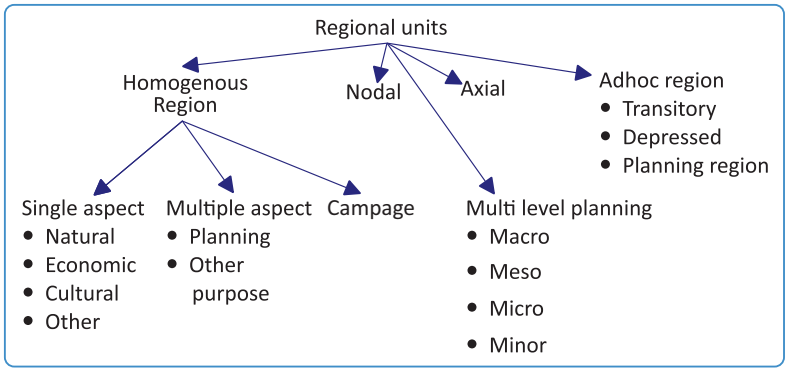


Fig. 7.2: Structure of a Region

- **Node:** Here polarization or centralization of Phenomenon is found. Nodes develop in functional regions but unidentified in formal regions.
- **Zone:** It is a segment of space/part of an area where intensity and magnitude of phenomenon is maximum.
- **Area:** It includes Node + Zone + Transitional Boundaries.

Thus,

Region = Node + Zone + Transitional Boundaries

Types of Regions

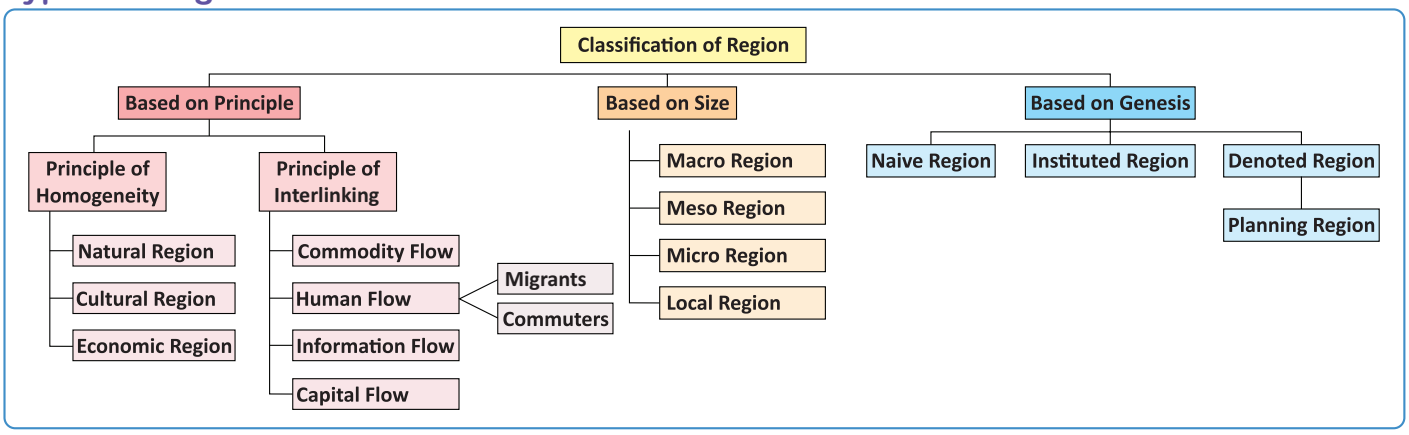


Fig. 7.3: Types of Regions

- **Formal Region:** Homogeneous regions, like the Himalayan or Sub-Tropical Region, exhibit uniformity based on distinct characteristics.
- **Functional Region:** Also termed Nodal Functional or **Polarized Region**, it showcases both homogeneity and heterogeneity, organized around a central node, such as the circulation area of a newspaper.
- **Vernacular Region:** Known as the **Perceptual Region,** it represents a spatial unit where inhabitants share a cultural identity and consider themselves interconnected by history and mutual interests.
- **Ad Hoc Region:** Often referred to as the **Planning Region,** this geographical area is designated for development plans to address regional problems and can be both formal and functional, exemplified by the Delhi Metropolitan Region.
- **Macro, Meso, Micro Regions:** Categories based on scale, where Macro regions represent larger areas, Meso regions intermediate areas, and Micro regions smaller areas.
- **Developed, Developing, Backward Regions:** Classification based on the stage of development, with Developed regions being economically advanced, Developing regions in transition, and Backward regions economically less developed.

Issues of Regional Imbalances

In the realm of human geography, regional imbalances pose significant challenges, reflecting disparities in various aspects across different areas. These imbalances are complex and multifaceted, impacting the social, economic, and cultural fabric of regions. Here are key issues associated with regional imbalances:

- **Environmental Issues:** Regional imbalances can lead to environmental issues, such as pollution and resource depletion, particularly in areas with high concentrations of economic activity. Unequal resource utilization and climate vulnerability contribute to environmental degradation.
- **Social Issues:** Regional imbalances can lead to social issues, such as migration, unemployment, poverty, crime, and conflict, especially in areas that are left behind or marginalized by development. Differences in education, healthcare access, and overall living standards impact societal well-being.
- **Political Issues:** Regional imbalances can lead to political issues, such as resentment, agitation, separatism, and violence, among regions that feel neglected or exploited by the central or dominant regions. Unequal resource allocation and representation lead to political marginalization of certain regions.
- **Economic Disparities:** Varying income levels, job opportunities, and industrial development contribute to economic inequalities. Regional imbalances can lead to unequal development and concentration of economic activity in certain areas, leading to regional disparities and inequality
- **Urban-Rural Divide:** Concentration of development in urban areas neglects rural regions, creating infrastructure imbalances.
- **Cultural and Linguistic Differences:** Variances in cultural preservation and linguistic diversity affect regional identity.
- **Migration Patterns:** Internal migration imbalances and brain drain impact population distribution and skills loss.
- **Infrastructure Development:** Disparities in transportation, digital infrastructure, and overall connectivity hinder balanced growth.

Addressing these regional imbalances requires comprehensive planning, targeted policies, and focus on inclusive development to ensure equitable growth across diverse geographical areas.

Regional Planning

Regional planning is a form of planning that covers a larger area of land than an individual city or town. It aims to coordinate the land use, infrastructure, and development of different regions, taking into account their existing conditions, needs, and future demands. Regional planning can help to achieve balanced and sustainable growth, reduce regional disparities and inequalities, and foster regional cooperation and integration.

IGNITE YOUR MIND

Sustainable Solutions or Short-Term Gains: How can regional planning prioritize long-term sustainability while addressing immediate needs for economic growth and infrastructure development? Can we achieve both simultaneously?

Examples of Regional Planning:

- **National Capital Region (NCR), India:**
  - **Scope:** Encompasses Delhi and surrounding areas in **Haryana, Uttar Pradesh, and Rajasthan.**
  - **Objective:** Coordinated development of the federal district for optimal functionality.
- **European Spatial Development Perspective (ESDP):**
  - **Scope:** Policy framework for spatial cohesion among European Union member states.
  - **Objective:** Promoting cooperation and harmonized development across Europe.
- **Regional Plan Association (RPA), New York:**
  - **Nature:** Non-profit organization advocating for long-term planning in the New York metropolitan region.
  - **Objective:** Providing policy solutions for sustainable and well-coordinated regional development.

Principles of Regional Planning:

1. **Vertical Unity Principle:** Everything in a region is **connected** and **affects each other.**
2. **Horizontal Spatial Unity Principle:** Each region is part of a **bigger system** and works with other regions.
3. **Space-Time Continuum Principle:** Planning for a region considers both **space and time.**
4. **Comprehensive Development Principle:** Planning for a region aims to **improve everything and everyone** in it.
5. **Community Development Principle:** Planning for a region gives everyone a chance to grow.
6. **Equilibrium between Social Desirability and Economic Viability Principle:** Planning for a region balances what people want and what is **economically viable.**
7. **Ecological Equilibrium Principle:** Planning for a region does not harm the environment.

Objectives of Regional Planning:

- To achieve balanced and sustainable development of the region and its sub-regions.
- To reduce regional disparities and inequalities in terms of income, employment, education, health, and other indicators of human development.
- To promote regional integration and cooperation among different regions and stakeholders.
- To protect and enhance the natural and cultural resources of the region and its environment.
- To optimize the use of land, water, energy, and other resources in the region and avoid wastage and conflicts.
- To foster social justice and equity for all groups and communities in the region.

Regional Planning in India

- Prime Minister Jawaharlal Nehru recognized the need for **balanced regional development** to address disparities and achieve national goals in the **First Five Year Plan (1951-56).**

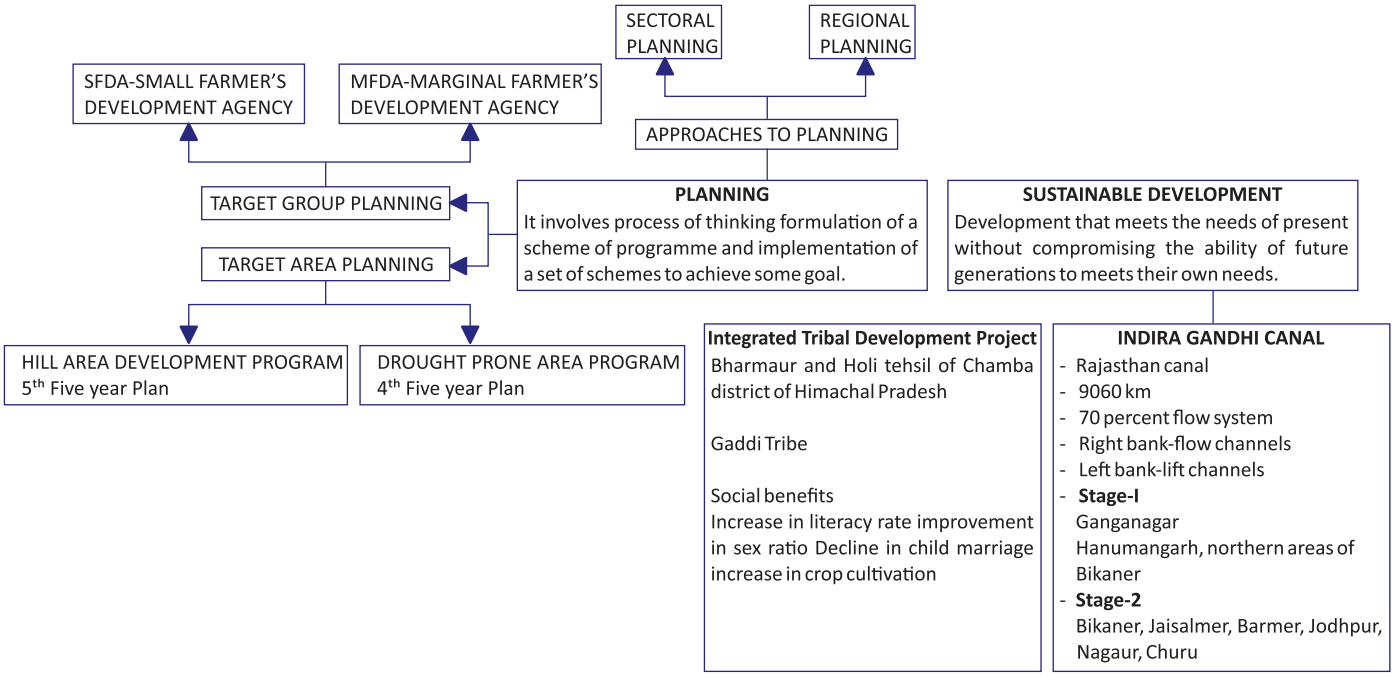

SECTORAL PLANNING
REGIONAL PLANNING
SFDA-SMALL FARMER'S DEVELOPMENT AGENCY
MFDA-MARGINAL FARMER'S DEVELOPMENT AGENCY
APPROACHES TO PLANNING
TARGET GROUP PLANNING
TARGET AREA PLANNING
PLANNING
It involves process of thinking formulation of a scheme of programme and implementation of a set of schemes to achieve some goal.
SUSTAINABLE DEVELOPMENT
Development that meets the needs of present without compromising the ability of future generations to meets their own needs.
HILL AREA DEVELOPMENT PROGRAM
5th Five year Plan
DROUGHT PRONE AREA PROGRAM
4th Five year Plan
Integrated Tribal Development Project
Bharmaur and Holi tehsil of Chamba district of Himachal Pradesh
Gaddi Tribe
Social benefits
Increase in literacy rate improvement in sex ratio Decline in child marriage increase in crop cultivation
INDIRA GANDHI CANAL
- Rajasthan canal
- 9060 km
- 70 percent flow system
- Right bank-flow channels
- Left bank-lift channels
- Stage-I
Ganganagar
Hanumangarh, northern areas of Bikaner
- Stage-2
Bikaner, Jaisalmer, Barmer, Jodhpur, Nagaur, Churu

Fig. 7.4: Regional Planning in India

- It led to the creation of the **Town and Country Planning Organisation (TCPO)** in 1962.
- **Formal Regional Plans:** The Mumbai Metropolitan Region Development Authority (MMRDA) in 1975 marked the first formal regional plan in India. Similar initiatives followed in regions like Delhi, Kolkata, and Chennai.
- **Holistic Evolution:** Over the years, regional planning strategies have evolved to become more holistic and participatory. Focus areas have shifted from primarily industrial development to encompass **social, environmental, and cultural aspects.**
- **Constitutional Amendments (1992):** The 73rd and 74th Constitutional Amendments (1992) empowered local bodies, facilitating decentralized planning with community involvement.

Target Area Planning

Background:

- Special attention must be given in the planning process to regions that have lagged behind economically.
- Economic development is intricately tied to the available resources in a region; however, even resource-rich areas can experience economic backwardness.
- Successful economic development necessitates not only resources but also technology and investment.

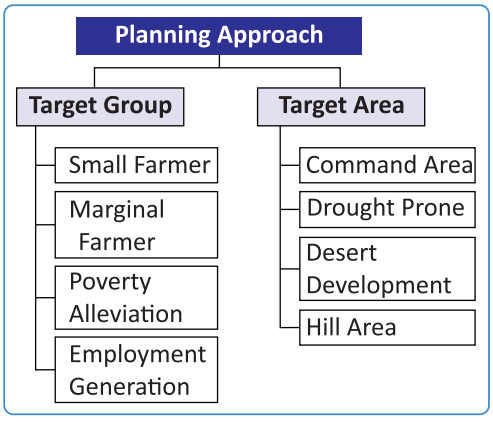


Fig. 7.5: Planning Approaches

Planning Commission Initiatives:

- Drawing from approximately one-and-a-half decades of planning experience, it became evident that regional economic imbalances were worsening.
- To address the deepening disparities in regional and social development, the Planning Commission introduced the 'target area' and 'target group' approaches to planning.

Notable Programs:

- Various programs were launched to address specific regional and social development challenges.
- These include the Command Area Development Programme, Drought Prone Area Development Programme, Desert Development Programme, and Hill Area Development Programme.
- On the other hand, initiatives like the Small Farmers Development Agency (SFDA) and Marginal Farmers Development Agency (MFDA) exemplify target group-focused programs.

8th Five Year Plan:

- Special area programs were formulated to enhance infrastructure in hill areas, north-eastern states, tribal regions, and economically backward areas.

IGNITE YOUR MIND

Top-Down or Bottom-Up: Should regional development strategies be dictated by central authorities or driven by local communities? What are the pros and cons of each approach, and how can we find a balance?

Integrated Rural Development Programmes

Integrated Rural Development Programmes (IRDPs) are government initiatives aimed at improving the lives of people living in rural areas, particularly those below the poverty line. These programs focus on a holistic approach, addressing various aspects of rural development like:

- **Economic Development:**
  - **Providing income-generating assets:** This could include livestock, agricultural equipment, or tools for starting small businesses, enabling beneficiaries to become self-employed.
  - **Skill development:** Training programs equip individuals with relevant skills for better employment opportunities.
  - **Microfinance:** Access to loans and financial services empowers rural communities to invest in small ventures and improve their livelihoods.
- **Social Development:**
  - **Education and healthcare:** Ensuring access to quality education and healthcare services improves the overall well-being of rural communities.
  - **Social welfare:** Programs cater to specific needs like providing support to women, children, and vulnerable groups.
  - **Infrastructure development:** Building roads, irrigation systems, and other infrastructure enhances connectivity and access to essential resources.
- **Environmental Development:**
  - **Sustainable agriculture:** Promoting practices that conserve soil and water resources while ensuring food security.
  - **Renewable energy:** Encouraging the use of renewable energy sources for cleaner and sustainable rural development.

- **Natural resource management:** Protecting forests, biodiversity, and other natural resources.
- Aimed at poverty alleviation through productive assets, technology, and skills for the poorest households.
- Social services like health, education, and housing integral to the program.
- Swarnjayanti Gram Swarozgar Yojna replaced IRDP in 1999 for rural poverty alleviation.
- Implemented by Panchayat Samitis.
- **Beneficiaries:** Artists, laborers, farmers, and economically disadvantaged individuals with an annual income below Rs 11,000.
- **Subsidies Provided:** Ranged from 25% to 50% for different categories, including SC/ST households and differently-abled individuals.
- **Implementation:** Executed by Block personnel, District Rural Development Agencies (DRDAs), and State Level Coordination Committee (SLCC).
- **Funding:** Centrally sponsored scheme with a 50:50 split between the union government and states.

❑ **Targeted Areas:**
- **Madhya Pradesh and Orissa:** Tribal Areas
- **Punjab, Haryana, Andhra Pradesh:** Agriculturally Developed
- **Eastern Uttar Pradesh, Maharashtra:** Agriculturally Underdeveloped
- **Jammu and Kashmir, West Bengal, Tamil Nadu:** Hilly Regions
- **Desert areas of Rajasthan:** Well-Run Administrations
- **Gujarat, Kerala, Karnataka:** Well-Run Administrations
- **Bihar, Himachal Pradesh, Madhya Pradesh:** Inadequate Administrations

❑ **Examples of IRDPs in India:**
- **Swarnjayanti Gram Swarozgar Yojana (SGSY):** Successor to IRDP, focuses on self-employment generation through micro-enterprises.
- **National Rural Livelihood Mission (NRLM):** Aims to empower communities through skill development and enterprise promotion.
- **Rashtriya Krishi Vikas Yojana (RKVY):** Promotes sustainable agriculture and improves agricultural productivity.
- **Pradhan Mantri Gram Sadak Yojana (PMGSY):** Connects rural villages with all-weather roads.

❑ **Evaluation:**
- Lack of consistent setup procedures for District Rural Development Agency (DRDA).
- Poor planning due to insufficient resource surveys and inadequate training for officers.
- Some states did not fulfill the 50% obligation, and there was a lack of follow-up for asset upkeep.
- Over 6 lakh families benefited from IRDP in 44 years, contributing to poverty alleviation. Despite criticisms, the initiative played a significant role in lowering poverty levels.

Panchayati Raj and Decentralised Planning

Panchayati Raj and Decentralised Planning are two concepts that are related to the system of local self-government in India.

❑ **Historical Context:**
- Rooted in the Gandhian vision, **Panchayati Raj** and **Decentralised Planning** in India trace their origins to the concept of self-reliant villages (gram swaraj).
- The emphasis is on empowering local communities to actively participate in their own developmental processes.

❑ **Formal Establishment (1992):**
- The formal establishment of **Panchayati Raj** institutions **(PRIs)** took place in 1992 through the **73rd Constitutional Amendment Act.**

❑ **Panchayati Raj Structure:**
- **Panchayati Raj** refers to the organized three-tier structure of elected rural bodies.
- The levels include the **village, block, and district,** each contributing to the governance and developmental processes.

❑ **Decentralised Planning:**
- This concept involves actively engaging local bodies and communities in the formulation and execution of development schemes and programs.
- The goal is to ensure that decision-making is decentralized, incorporating local insights and needs.

❑ **Objectives: Panchayati Raj** and **Decentralised Planning** aim to,
- Promote grassroots democracy and active community participation in development.
- Address social justice issues and empower rural populations.

❑ **Benefits:** The implementation of **Panchayati Raj** and **Decentralised Planning** brings about several advantages,
- Empowerment of local communities to identify and address their specific needs.
- Ensuring transparency and accountability among public officials and elected representatives.
- Facilitating the inclusion and representation of marginalized sections like women and other disadvantaged groups.
- Coordinating and converging various development programs at the local level.
- Enhancing the overall quality and efficiency of public service delivery and infrastructure development.

Command Area Development

Command Area Development is a programme that aims **to improve the utilization of irrigation potential and increase agricultural productivity** in the areas served by irrigation projects.

- **Objective and Activities:** Aims to achieve these goals through various activities like **Water management, Land leveling, Soil conservation, Crop diversification and Farmers' participation.**

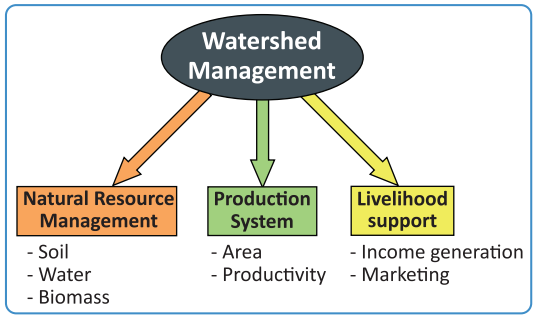


Fig. 7.6: Watershed Management

- **Historical Context:** Originated in the mid-20th century in response to the imperative of maximizing water resources and improving crop yields. In India, the Command Area Development Programme (CADP) was initiated in December 1974 during Fifth Five Year Plan.
- **Global Significance:** Other countries with similar agricultural landscapes have adopted their versions of the Command Area Development Programme (CADP), emphasizing its global relevance.

Benefits of Command Area Development

- **Water Conservation:**
  - Reduces water wastage.
  - Ensures uniform water distribution across the command area.
- **Agricultural Productivity:** Enhances crop yield and quality.
- **Socio-economic Impact:** It improves the income and livelihoods of farmers. It fosters inclusion and empowerment of marginalized groups like women and backward classes.
- **Sustainability and Environment:** It promotes sustainable agriculture and contributes to environmental conservation.

Case Study Indira Gandhi Canal (Nahar) Command Area

The Indira Gandhi Canal (Nahar) Command Area is the region that receives irrigation water from the Indira Gandhi Canal, the longest canal in India. The canal **originates from the Harike Barrage near the confluence of the Satluj and Beas rivers in Punjab and ends in the Thar Desert in Rajasthan.** The canal project aims to provide water for drinking, agriculture, and industry in the arid and semi-arid areas of Rajasthan. The canal project has two stages:

- Stage-I lies in Ganganagar, Hanumangarh and northern part of Bikaner districts, with a culturable command area (CCA) of 5.53 lakh hectares.
- Stage II covers the districts of Bikaner, Jaisalmer, Barmer, Jodhpur, Nagaur, and Churu, with a CCA of 14.1 lakh hectares. The canal also has several lift canals to raise the water level in some areas. The total CCA of the canal project is estimated to be 19.63 lakh hectares.

Fig. 7.7: Indira Gandhi Canal (Nahar) Command Area

National Capital Region

The **National Capital Region (NCR)** in India is strategically centered around the **National Capital Territory (NCT)** of Delhi.

- **Geographical Coverage:** It extends to include the national capital, **Delhi,** as well as several districts from the states of **Haryana, Uttar Pradesh, and Rajasthan.**
- **Formation and Authority:** Established in 1985, the NCR is governed by the **National Capital Region Planning Board (NCRPB).** The primary objective is to plan and coordinate development while formulating policies for **land-use control** and **infrastructure development.**
- **City-Region Concept:** The NCR is conceptualized as a **city-region,** emphasizing a spatial unit comprising the core city (Delhi) and its surrounding areas that exhibit functional and economic interdependence.
- **Regional Planning Approach:** Aligned with the principles of the **regional planning approach,** the NCR emphasizes the coordination and integration of development activities across different sectors and areas within the region.

- **Creation Goals:** The creation of the NCR was driven by the goal **to contain the uncontrolled growth of Delhi as the core city.** It aims to regulate and control development in the surrounding region, promoting sustainability in the process.

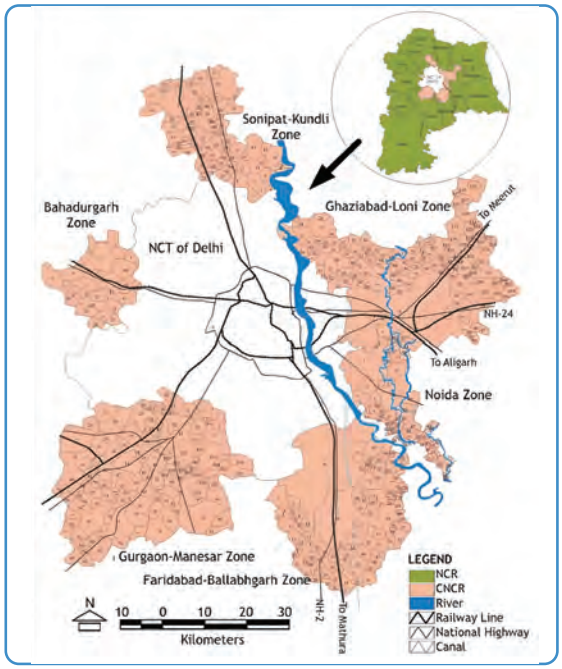


Fig. 7.8: National Capital Region

Concept of Magnet Cities

The concept of magnet cities refers to the idea that some cities have a strong attraction for people, investment, innovation, and culture. These cities are able to **offer a high quality of life, a vibrant economy, and a diverse society to their residents and visitors.** Magnet cities are also able to adapt to changing circumstances and challenges, and to create opportunities for growth and development.

Examples: Delhi, Mumbai, Bengaluru etc.

Some of the factors that make cities magnets are:

- **City size:** Larger cities tend to have more benefits and opportunities in terms of employment, education, entertainment, and social interaction. They also have more resources and infrastructure to support their population and activities.
- **Proximity to density:** Cities that are close to other large or dense cities can benefit from the spillover effects of their neighbors, such as access to markets, networks, and innovation. They can also complement each other by offering different services and amenities.
- **Proximity to markets:** Cities that are strategically located near important markets, such as trade hubs, ports, or border crossings, can have an advantage in terms of economic activity and connectivity. They can also attract more investment and tourism by being easily accessible.
- **Universities:** Cities that have universities can have a steady supply of young, educated, and creative people, who can contribute to the human capital and innovation of the city. Universities can also foster collaboration and knowledge exchange among different sectors and disciplines.

Advantages of Magnet Cities:

- **Opportunities:** Create more opportunities for employment, education, entertainment, and social interaction.
- **Innovation:** Foster innovation, creativity, and diversity by attracting talent, capital, and ideas.
- **Competitiveness:** Enhance global competitiveness and influence through connections to important markets and networks.
- **Environmental Sustainability:** Improve environmental sustainability and resilience via smart and green technologies.

Limitations of Magnet Cities:

- **Challenges:** Face challenges of congestion, pollution, inequality, and crime due to rapid and unbalanced growth.
- **Socio-cultural identity:** Suffer from a loss of identity, culture, and community due to homogenization and gentrification.
- **Conflicts:** Encounter conflicts and tensions among different groups and interests due to diversity and complexity.
- **Vulnerability:** Become vulnerable to external shocks and uncertainties due to dependence on other actors and factors.

Counter Magnet Cities

Counter magnet **cities are cities that are developed as alternative hubs of development** and have the potential to attract more people and immigrants from a larger and more popular city in the area.

The main purpose of counter magnet cities is to reduce the pressure and congestion on the main city and to promote balanced and sustainable regional development.

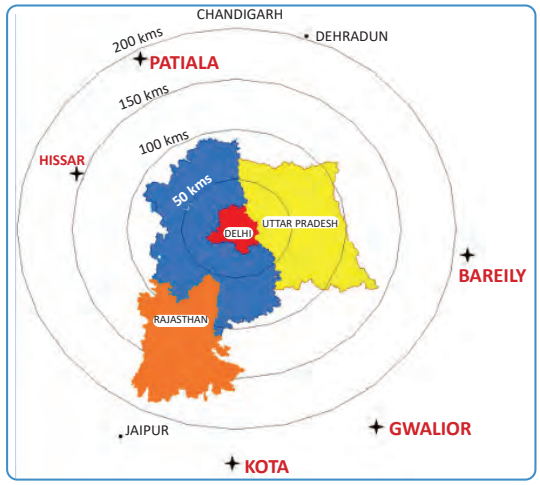


Fig. 7.9: Counter Magnet Cities for Delhi

Examples of counter magnet cities:

- **Hisar:** Hisar is a counter magnet city for Delhi, located in the state of Haryana. It is an industrial and agricultural center, with sectors such as steel, textiles, food processing, and auto components. It is also a hub of education and research, with institutions such as Chaudhary Charan Singh Haryana Agricultural University and Guru Jambheshwar University of Science and Technology.
- **Bareilly:** Bareilly is a counter magnet city for Delhi, located in the state of Uttar Pradesh. It is a commercial and cultural center, with sectors such as handicrafts, furniture, textiles, and sugar.
- **Kota:** Kota is a counter magnet city for Delhi, located in the state of Rajasthan. It is an industrial and educational center, with sectors such as engineering, chemicals, fertilizers, and power. It is also famous for its coaching institutes for engineering and medical entrance exams, which attract thousands of students every year.

Magnet vs. Counter Magnet City

Feature	Magnet City	Counter Magnet City
Definition	A city with a strong pull factor, attracting people, investment, and opportunities, often due to existing advantages, historical significance, or natural resources.	A city strategically developed as an alternative hub to divert population and economic activities from a larger, congested city, aiming for balanced regional development.
Purpose	Attract population and resources, leading to economic growth and cultural influence.	Reduce pressure on a major city, promote balanced regional development, and provide alternative opportunities and focus.
Focus	Development and growth concentrated on a central, highly populated city, often leading to challenges like congestion and inequality.	Serves as a secondary center of development, easing strain on the main city and fostering a more sustainable and equitable distribution of resources.
Examples	New York City, Tokyo, London, Mumbai, Delhi, Bangalore.	Noida (to Delhi), Gurgaon (to Delhi), Faridabad (to Delhi-NCR), Greater Noida, Ghaziabad (to Delhi-NCR), Pune (to Mumbai).
Effect on Main City	Can lead to congestion, high cost of living, uneven development, and environmental issues.	Alleviates congestion, provides additional opportunities, supports overall regional development, and promotes environmental sustainability.
Government intervention	Often evolves organically due to economic opportunities and cultural significance, with limited government intervention.	Requires deliberate planning and development by the government to create a balanced urban hierarchy and attract population and businesses.
Objective	Centralized growth, economic power, and cultural dominance.	Decentralized growth, regional balance, sustainable development, and improved quality of life.
Population Movement	Draws people toward the primary city, creating population pressure and potential strain on resources.	Attracts population away from the main city, redistributing economic activities and promoting balanced population distribution.
Challenges	Urban challenges like congestion, housing scarcity, infrastructure overload, and environmental pollution.	Initial challenges in establishing necessary infrastructure, attracting businesses and residents, and overcoming existing economic disparities between regions.

IGNITE YOUR MIND

Technology's Double-Edged Sword: How can technological advancements like smart cities and AI-powered resource management be harnessed for regional development? What are the potential ethical and social concerns associated with these technologies?

Regional Planning And Development of Island Territories

- **Definition:** It refers to the process of designing and implementing strategies to promote sustainable growth, infrastructure development, and socio-economic progress in islands.
- **Challenges:** Island territories face unique challenges such as limited land availability, vulnerability to natural disasters, and isolation from the mainland.

Examples of Implemented Initiatives:

- **ANIDP (Andaman and Nicobar Islands Development Programme) 2005:** Focuses on sustainable development, emphasizing infrastructure, tourism, and environmental conservation.
- **IIMPs (Integrated Island Management Plan) for Lakshadweep 2016:** Aims at sustainable development with a focus on infrastructure, tourism, and environmental conservation.
- **EU's Smart Islands Initiative (European Union) 2017:** Aims to transform islands into smart, sustainable communities, emphasizing renewable energy, water and waste management, and digital connectivity.

Tribal Area Development Program

- **Definition:** The Tribal Area Development Program (TADP) is a government initiative in India that aims to address the developmental needs of tribal communities and to improve their socio-economic status.
- **Implementing Authority:** It is implemented by the Ministry of Tribal Affairs and aims to provide basic amenities, such as education, health care, and infrastructure, to tribal areas.

Some of the objectives of the TADP are:

- To protect the tribal culture and identity, and to promote their participation in the democratic process.
- To enhance the income and livelihood of the tribal people, and to reduce their poverty and vulnerability.
- To improve the access and quality of education, health care, and other social services for the tribal people.
- To develop the infrastructure and connectivity of the tribal areas, and to ensure their environmental sustainability.

Some of the strategies of the TADP are:

- To adopt a tribal sub-plan approach, which allocates funds and resources for the tribal areas in proportion to their population and needs.
- To establish integrated tribal development projects (ITDPs), which cover areas of high tribal concentration and coordinate the implementation of various schemes and programmes.
- To involve the tribal people and their institutions, such as Panchayati Raj and Gram Sabhas, in the planning and monitoring of the development interventions.
- To provide financial and technical assistance to the state governments and the voluntary organizations for the execution of the projects of regional importance.

TADP faces many challenges in its implementation, such as:

- Lack of coordination and convergence among different ministries, departments, and agencies involved in tribal development.
- Inadequate allocation and utilization of funds, especially the Scheduled Tribe Component (STC) and the District Mineral Foundation (DMF) funds.
- Poor monitoring and evaluation of the outcomes and impacts of the tribal development programmes and schemes.
- Low awareness and participation of the tribal communities in the planning and implementation of the programmes and schemes.
- Land alienation, indebtedness, displacement, and identity crisis among the tribal people due to urbanization, industrialization, and forest policies.
- Low literacy, education, health, nutrition, and hygiene levels among the tribal people compared to the national average.
- Resistance to change and adaptation to mainstream society and culture by some tribal groups.

Way Forward:

- Strengthening the implementation and monitoring of the **Forest Rights Act 2006,** which recognizes the individual and community rights of the tribal people over forest resources.
- Enhancing the integration and **convergence of the tribal development programmes and schemes with other central and state government initiatives,** such as the National Rural Livelihood Mission, the Swachh Bharat Mission, the National Health Mission, etc.
- Setting up systems and mechanisms, especially **ICT-enabled tools, for effective implementation and monitoring** of the tribal development programmes and schemes.
- Ensuring evidence-based dialogue and consultation with the tribal communities and their representatives in the planning and implementation of the tribal development programmes and schemes.
- Improving the allocation and utilization of the **Scheduled Tribe Component (STC) and the District Mineral Foundation (DMF) funds** for the tribal development programmes and schemes.
- Enhancing the **capacity building and empowerment** of the tribal people, especially the women and youth, through education, skill development, entrepreneurship, and leadership training.
- Promoting the preservation and **promotion of the tribal culture, language, and identity** through various media and platforms.

IGNITE YOUR MIND

Cultural Crossroads or Conflict Zones?: How can regional planning foster collaboration and understanding between diverse cultures and ethnicities within a region? Can it also unintentionally exacerbate existing tensions?

Case Study – Integrated Tribal Development Project in Bharmaur Region

The Integrated Tribal Development Project (ITDP) in Bharmaur region is a scheme that aims to improve the quality of life of the Gaddi tribes, who are the main inhabitants of this area in Himachal Pradesh. The Gaddis are a pastoral community who practice transhumance, i.e., seasonal migration with their livestock.

The ITDP was introduced in 1974 as part of the tribal sub-plan under the fifth five-year plan. The ITDP focuses on various aspects of development, such as education, health, infrastructure, livelihood, and preservation of tribal culture and heritage.

Some of the social benefits of the ITDP in Bharmaur region are:

- The female literacy rate increased from 1.88 percent in 1971 to 65 percent in 2011, with a significant improvement in female literacy and reduction in gender gap.
- Child marriage has decreased and the age at marriage has increased.
- There has been a rapid increase in infrastructure in terms of availability of roads, schools, and hospitals.
- The cultivation of pulses and cash crops has increased, and the dependence on pastoralism has declined.
- The Gaddis have been able to preserve their distinct identity, language, and culture.

Hill Area Development Programme

The Hill Area Development Programme (HADP) is a government initiative to promote the sustainable development of the hilly regions in India. It was launched during the Fifth Five Year Plan

(1974-79) and covers 15 districts in four states: Uttarakhand, Assam, West Bengal, and Tamil Nadu.

The main objectives of the HADP:

- Conserve and restore the ecological balance of the hill areas.
- Enhance the socio-economic well-being of the hill people.
- Integrate the hill areas with the national development process
- Ensure people's participation in all development activities

The HADP adopts a watershed-based approach to plan and implement various projects in sectors such as horticulture, agriculture, animal husbandry, forestry, tourism, mining, and infrastructure.

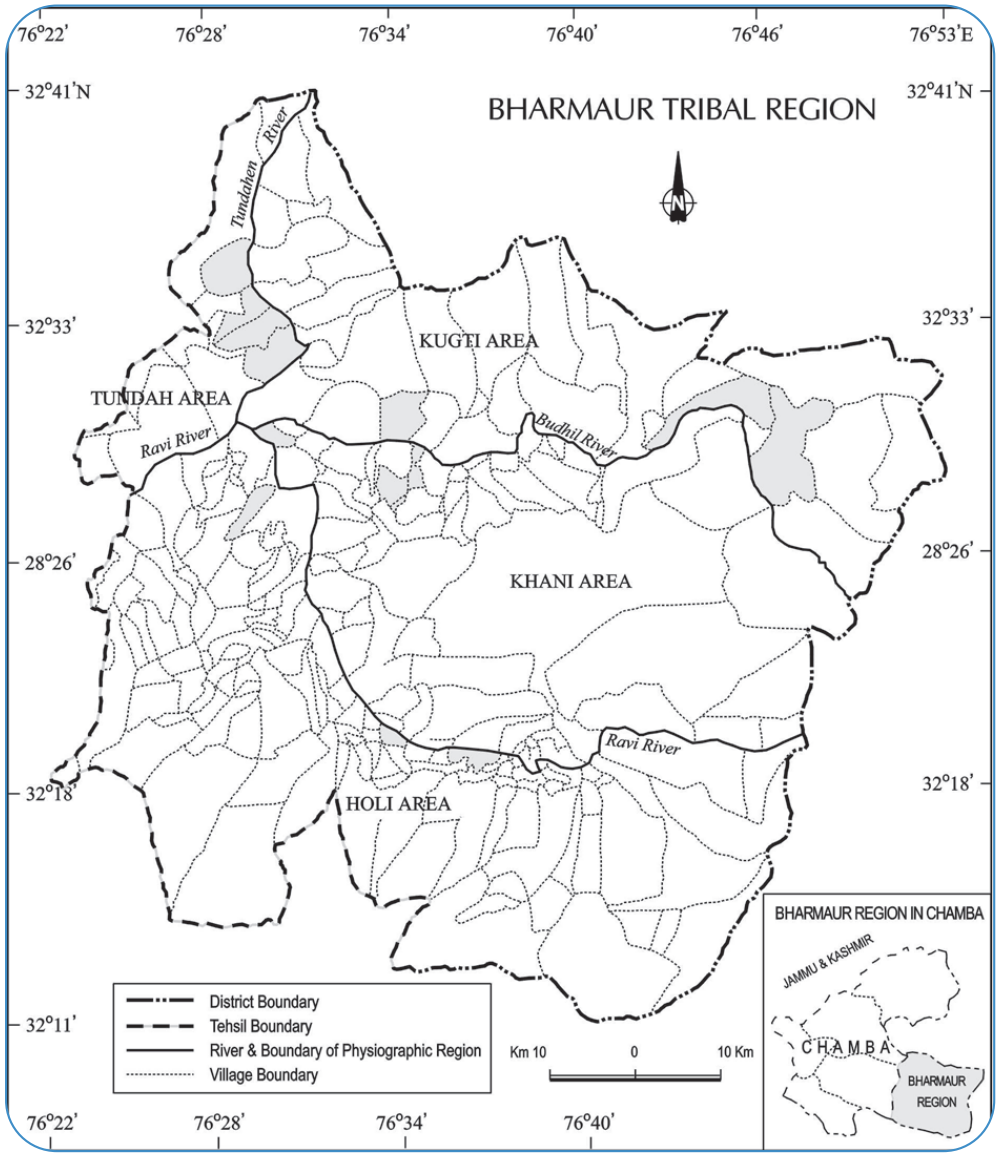


Fig. 7.10: Bharmaur Triba Region, Himachal Pradesh

The HADP aims to address the challenges faced by the hill areas such as,

- Environmental degradation due to deforestation, soil erosion, and natural disasters
- Shortage of land and water resources due to population growth and urbanization
- Lack of basic infrastructure and connectivity
- Poverty, malnutrition, and health issues
- Low productivity and income opportunities

The HADP is **funded by the central government** through special central assistance and is implemented by the state governments through their respective planning departments. The HADP is monitored and evaluated by the **Ministry of Development of North Eastern Region (DoNER).**

Way Forward to strengthen the HADP:

- Enhancing the **coordination** and **convergence** among various stakeholders and schemes
- Improving the **data availability** and **quality** for planning and monitoring
- Incorporating the **best practices** and **innovations** from other hill regions and countries
- Increasing the **awareness** and **involvement** of the local communities and institutions
- Addressing the **emerging issues** and **challenges** such as climate change, disaster management, and urbanization

Integrated Watershed Management Programme (IWMP)

- Integrated Watershed Management Programme (IWMP) is a scheme **implemented by the Department of Land Resources of the Ministry of Rural Development.** The main objective of IWMP is to restore the ecological balance by harnessing, conserving and developing degraded natural resources such as soil, vegetative cover and water. IWMP follows a holistic approach that includes capacity building, livelihood activities, production system, natural resource management, and a dedicated institutional system for effective and comprehensive implementation.
- IWMP is the second largest watershed programme in the world after China's. It was launched in 2009 by merging **three earlier programmes:** Drought Prone Areas Programme (DPAP), Desert Development Programme (DDP) and Integrated Wastelands Development Programme (IWDP).

Desert Development Programme (DDP)

- The Desert Development Programme (DDP) is a scheme by the **Department of Land Resources,** Ministry of Rural Development, Government of India. It aims to **minimise the adverse effect of drought and control desertification through rejuvenation of the natural resource** base of the identified desert areas. The programme strives to achieve ecological balance in the long run and promote overall economic development and social welfare of the people living in these areas.
- The programme is **funded on the basis of 75:25** by the Central and State government. The DDP covers 235 blocks of 40 districts in 7 States/UTs Rajasthan, Gujarat, Haryana, Karnataka, Andhra Pradesh, Himachal Pradesh and Jammu & Kashmir. The programme was introduced in 1977-78 and has been revised several times since then.

Successes and Limitations of DDP:

- **Successes:**
  - The DDP has **helped to conserve water resources,** enhance soil quality, and increase agricultural productivity in the desert areas.
  - The DDP has also **promoted diversification of crops, livestock development, renewable energy,** infrastructure development, and skill development among the desert communities.
  - The DDP has contributed to the **ecological balance, economic development, and social welfare** of the desert regions.
- **Limitations:**
  - The DDP faces challenges such as **inadequate funding, lack of coordination,** weak monitoring and evaluation, and low participation of the stakeholders.
  - The DDP also suffers from the **problems of land degradation, water scarcity, climate change,** and human-wildlife conflicts in the desert areas.
  - The DDP needs to adopt a **more integrated, participatory, and adaptive approach** to address the complex and dynamic issues of the desert regions.

Drought Prone Area Programme

Drought Prone Area Programme (DPAP) is an initiative by the Indian government to address the challenges faced by areas that are frequently affected by drought. The main objective of the programme is to minimize the adverse effects of drought on crop and livestock production, land and water resources, and human well-being.

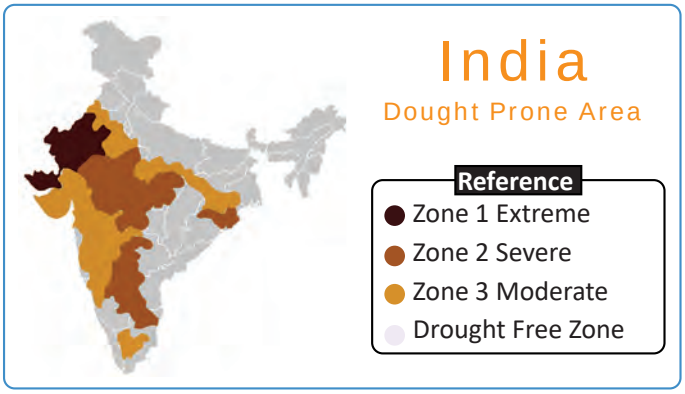


Fig. 7.11: Drought Prone Areas in India

- The programme also aims to promote economic development and improve the living conditions of the poor and marginalized people in the drought-prone areas.
- The programme was launched in 1973-74 and covers 972 blocks of 182 districts in 16 states. The programme **adopts a watershed-based approach** to conserve soil and water, enhance biomass production, and diversify livelihood options. The programme has been revised several times to incorporate new guidelines and norms.

Integrated Wastelands Development Programme (IWDP)

The Integrated Wastelands Development Programme (IWDP) is a scheme launched by the Government of India in 1989 to improve the productivity of non-forest wastelands and enhance the livelihoods of the rural poor who depend on them. The IWDP aims to restore ecological balance by harnessing rainwater, promoting afforestation, soil conservation, and sustainable agriculture. The **IWDP is implemented through a participatory approach** involving local communities, NGOs, and government agencies. The IWDP is one of the major programmes under the Department of Land Resources, Ministry of Rural Development.

IGNITE YOUR MIND

Planning Paradise or Paper Tiger?: How effective are regional planning initiatives in addressing complex issues like poverty, inequality, and environmental degradation? Are they merely aspirational documents or powerful tools for positive change?

GROWTH VS. DEVELOPMENT

Simply defined, **growth** refers to the absolute increase (positive growth) or decrease (negative growth) in the size of anything–a person, an organization or an economy. For example– a person's salary increases from Rs. 5,000 to Rs. 15,000 a month. **Development** on the other hand refers to a qualitative increase or improvement in anything. Continuing the above example– if that person goes on to live the exact same life without any rise in living standard, development did not take place despite growth. Hence, a person's ability to purchase an iPhone can be attributed to his growth but his ability to use that iPhone properly is his development. Growth is a quantitative phenomena while development is a qualitative phenomena.

Economic Growth vs. Economic Development

Basis	Economic Growth	Economic Development
Concept	It is a narrow concept which refers to an increase in country's real output of goods and services over a specific period of time.	It is a comprehensive concept which includes economic growth and progressive changes in social, economic, political, cultural and historical levels.
Attainment	It can be easily attained by mobilizing larger resources and raising their productivity	It is difficult to realize because it also involves such changes in the composition of output which will ensure social justice.
Significance	It attaches less significance to equitable distribution of income, reduction in unemployment and poverty level.	It attaches greater significance to equitable distribution of income, reduction in unemployment and poverty levels.

Differences and Considerations:

- **Not Necessarily the Same:** It's crucial to understand that high economic growth does not guarantee high economic development.
- **Shared Benefits:** Equitable distribution of growth benefits is essential for comprehensive development.
- **Environmental and Social Impact:** Growth should not come at the expense of environmental degradation or social issues.
- **Trade-off Possibility:** High economic development may coexist with low economic growth if investments prioritize well-being over increased output.

Why is GDP not a good indicator of development?

GDP is not a good indicator of development because **it only measures the economic output** of a country, but not the well-being or welfare of its people.

- GDP does not account for factors such as inequality, environmental impact, human rights, social justice, or happiness, which are important aspects of development.
- GDP also has limitations as a statistical measure, as it is based on estimates and assumptions that may not reflect the reality of a country's economy.
- Therefore, GDP alone cannot capture the multi-dimensional nature of development or the inherent shortcomings of capitalism.

Some alternative measures of development that have been proposed are the Human Development Index, which combines life expectancy, education, and income per capita, the Social Progress Index, which measures the extent to which countries provide for the social and environmental needs of their citizens, and the Genuine Progress Indicator, which adjusts GDP for income distribution, environmental costs, and social benefits. These indicators aim to provide a more comprehensive and holistic view of development than GDP.

HUMAN DEVELOPMENT: CONCEPT AND APPROACHES

The Modern Idea Of Development

- **Evolution of Idea:** The contemporary notion of development centers on the quality of life, opportunities, and freedoms within a country.
- **Origin:** Clearly articulated in the late eighties and early nineties, notably by South Asian economists Mahbub-ul-Haq and Amartya Sen.
- **Mahbub-ul-Haq's Perspective:**
  - **Definition:** Human development, according to Dr. Haq, expands people's choices and enhances their lives.
  - **Central Theme:** People are the focal point of all development efforts in this conceptualization.
- **Amartya Sen's Influence:**
  - **Focus:** Emphasis on capabilities and freedoms as key metrics of development.
  - **People-Centric:** Similar to Dr. Haq's approach, Sen underscores the centrality of individuals in the development process.
- **Key Components:**
  - **Quality of Life:** Includes well-being, health, and overall satisfaction.
  - **Opportunities:** Access to education, employment, and other avenues for personal growth.
  - **Freedoms:** Embracing political, social, and economic liberties.
  - **Human-Centric Approach:** Both Haq and Sen advocate for a people-centric development model, where the well-being and choices of individuals are prioritized.

Approaches to Human Development

- **INCOME APPROACH**
  - It is the oldest approach.
  - It believes human development is linked with income.
    - It measures development by using indicators such as Gross Domestic Product (GDP) or Gross National Income (GNI) per capita.
  - The higher the income the higher is the freedom any individual enjoys.
  - Better income means more development.

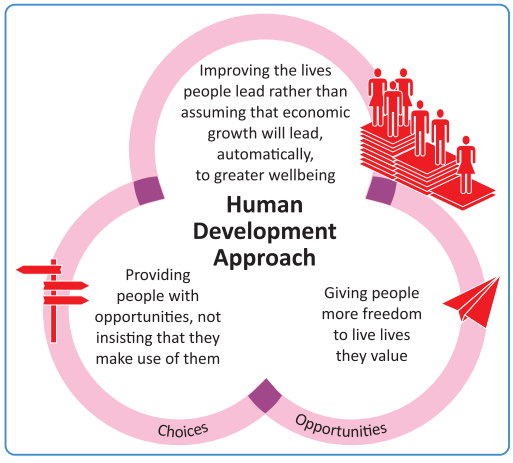

Improving the lives people lead rather than assuming that economic growth will lead, automatically, to greater wellbeing
Human Development Approach
Providing people with opportunities, not insisting that they make use of them
Giving people more freedom to live lives they value
Choices
Opportunities

Fig. 7.12: Approaches to Human Development

- **WELFARE APPROACH**
  - Considers humans as the centre of all development.
  - People are not participants of development but they are the recipients.
  - Government must maximise expenditure on welfare programmes.
  - Argues for higher government expenditure in sectors such as health, education, and amenities.
  - Measures development by using indicators such as public expenditure on social services or human welfare index.
- **BASIC NEEDS APPROACH**
  - Proposed by International Labour Organisation (ILO)
  - There are several basic needs, which must be fulfilled for all individuals.
    - These basic needs include food, clothing, housing, education, and public transportation.
  - It measures development by using indicators such as percentage of population below poverty line or basic needs satisfaction index

❑ **CAPABILITY APPROACH**

- Proposed by professor **Amartya Sen and Dr Mahbub-ul- Haqq**
- Believes human development aims at building capabilities in the areas of health, education and access to resources.
- Development enlarges the choices of people and makes them lead a meaningful life.
- It measures development by using indicators such as **Human Development Index (HDI) or Human Poverty Index (HPI)**.

Essential Pillars of Human Development

❑ **EQUITY:** Equity refers to giving equal opportunities to everybody residing in a nation irrespective of their gender, race, income and caste.

- ❒ In every society, it is found that one section of the society does not enjoy equal opportunity, and suffers from exclusion.
- ❒ Like in India, girl-child is not encouraged to have education and female literacy rate is found to be very low in few states. So, choices for this social group are limited.
- ❒ Hence, this group may not develop properly, as their capabilities can't be built, without proper education.

❑ **SUSTAINABILITY:** Sustainability means continuity in the availability of opportunities to the future generation too. If it is found that the present generation is misusing the resources.

- This may lead to the scarcity of environmental, financial and human resources for the future generation. They will suffer from natural disasters, climatic change and food scarcity.
- Future generations will have fewer opportunities and have limited choices.

❑ **PRODUCTIVITY:** Productivity here means human labour productivity or productivity in terms of human work. Such productivity must be constantly enriched by building capabilities in people.

- More productive workforce can only be created by providing knowledge(education) and good health (medical facilities).
- So, efforts to give education and better health facilities will ultimately build a productive workforce. Illiterate and sick people can never be efficient workers.

❑ **EMPOWERMENT:** Empowerment means to have the freedom to make choices. As we know, freedom to make choices is the fundamental condition in building capabilities, which is the basic goal of human development.

- Good governance and people-oriented policies are required to empower people. The empowerment of socially and economically disadvantaged groups is of special importance.

IGNITE YOUR MIND

Unequal Landscapes: Why do some regions consistently lag behind in human development? Is it purely economic factors, or are there deeper historical, cultural, and political forces at play?

Human Development Index

❑ **Definition:** HDI is a comprehensive statistical composite index employed by the United Nations Development Programme (UNDP) to categorize countries into four tiers based on human development.

❑ **Dimensions Measured:** The HDI is the geometric mean of normalized indices for each of the three dimensions of human development:

- **Long and Healthy Life:** Emphasizes life expectancy as a key indicator.
- **Being Knowledgeable:** Considers education and knowledge attainment.
- **Decent Standard of Living:** Evaluates income and living conditions.

❑ **Calculation:** HDI is derived as the geometric mean of normalized indices across the three dimensions, providing a holistic measure of development.

❑ **UNDP's Role:** HDI is a crucial metric presented in the UNDP's Human Development Report, offering insights into a country's overall development.

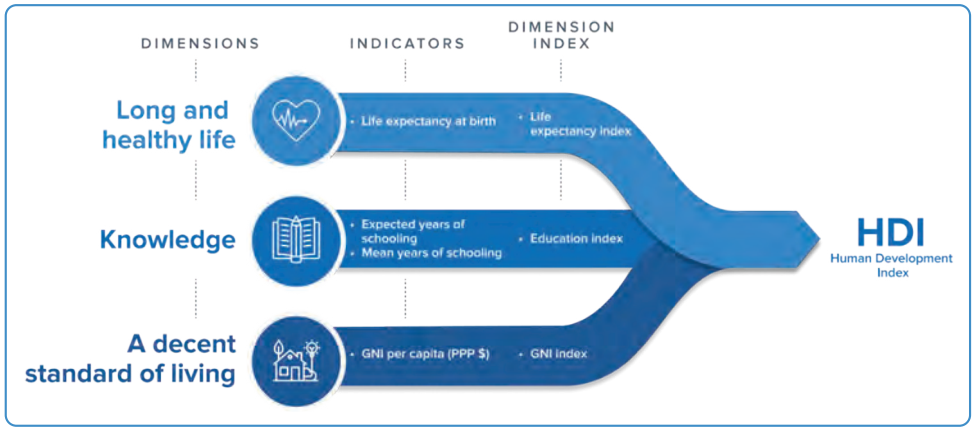


Fig. 7.13: Human Development Index (HDI)

- **India's HDI Ranking (2022):** According to the UNDP, India holds the **132nd position out of 191 countries** on the Human Development Index in the year 2022.
- **Significance:** HDI serves as a valuable tool for assessing and comparing the development status of nations, contributing to global policy discussions and initiatives.

Components of HDI

- **Life expectancy at birth:** long and healthy life is determined through the life expectancy index. For example, when the life expectancy at birth is 85 years, the Life Expectancy Index (LEI) is 1, and when it is 20 years, it is 0.
- **Expected years of schooling & Mean years of schooling:** It comes under the knowledge dimension of the HDI index. Acquired knowledge through mean and predicted years of education is measured through the education index. The two knowledge indicator values are first normalized using a minimum value of 0 and a maximum value of 15 for the mean years spent in school and 18 for the expected number of years.
- **GNI per capita (PPP $):** The technique measures a decent standard of living through the GNI index. The low minimum value of PPP is taken as $100. PPP $75,000 is the maximum value allowed.

Significance of HDI

- The HDI establishes "goalposts"—minimum and maximum values—for each dimension and then compares each nation's performance to them.
  - This is denoted by a number between 0 and 1.
- A country's HDI value increases with its level of human development.
- UNDP ranks countries based on their HDI reports every year. The closer a score is to one, the greater is the level of human development.
  - Therefore, a score of 0.983 would be considered very high while 0.268 would mean a very low level of human development.

Advantages of HDI

- **Holistic Well-being Measurement:** HDI considers **health, education,** and **income,** providing a comprehensive view of human well-being beyond just economic factors. **Example:** A country with a high HDI indicates not only economic prosperity but also citizens' good health and educational attainment.
- **Targeted Improvement Areas:** It helps pinpoint specific areas, like **healthcare, education,** and **infrastructure,** requiring immediate attention and enhancement. **Example:** HDI analysis may reveal a need for increased investment in **education** if literacy rates are low.
- **Policy Evaluation Tool:** Facilitates the assessment of how policies impact HDI outcomes, contributing to informed decision-making for sustainable development. **Example:** A policy promoting **healthcare** accessibility can be evaluated based on improved life expectancy and health indicators in the HDI.
- **Resource Allocation:** Supports the allocation of funds and resources for development initiatives or soliciting international aid based on identified needs. **Example:** If HDI highlights a lack of access to clean water, resources can be directed to **water infrastructure** projects.

Limitations of HDI

- **Inequality Oversight:** HDI's national average masks internal disparities, neglecting variations within countries. Certain regions or groups might exhibit significantly higher or lower HDI than the overall average. **Example:** While a country may have a high HDI, certain marginalized communities within it may still face challenges.
- **Limited Short-term Reflection:** Focused on long-term trends, HDI might not capture rapid changes or shocks, such as natural disasters, wars, or pandemics, which can impact human development in the short term. **Example:** A sudden economic downturn due to a global financial crisis might not be immediately reflected in HDI.
- **Exclusion of Key Factors:** HDI omits crucial aspects affecting well-being, such as **environmental quality, political freedom, social justice,** and **cultural diversity. Example:** A country might have a high HDI but lacks political freedoms, impacting the overall quality of life.
- **Data Reliability Concerns:** Dependency on potentially inaccurate, outdated, or unavailable data, coupled with the use of dynamic **Purchasing Power Parity (PPP)** values, can introduce uncertainty and variability across sources. **Example:** Inaccurate reporting of **health** or **education** statistics can compromise the reliability of HDI assessments.
- To address the limitations of HDI, later on another tool named Multidimensional Poverty Index Was devised.

India's Performance in HDI in 2022 as per UNDP Human Development Report 2021-2022

- **Education:**
  - **Expected Years of Schooling:** India falls short at 11.9 years compared to the world average of 13.0 years.
  - **Average Years of Schooling:** India lags with 6.7 years against the world average of 8.3 years.
  - **Comparison:** India ranks 132nd globally, falling in the medium human development category. Sri Lanka ranks 73rd and China ranks 79th.
- **Challenges in Education:**
  - Low enrollment and retention rates, especially among girls and marginalized groups.
  - Subpar teaching and learning outcomes.
  - Inadequate infrastructure and resource allocation.

- **Health:**
  - **Life Expectancy at Birth:** India stands at 67.2 years, below the world average of 73.4 years.
  - **Comparison:** India trails behind Sri Lanka (77.2 years) and China (77.9 years).
- **Challenges in Health:**
  - High maternal and child mortality rates.
  - Substantial burden of communicable and non-communicable diseases.
  - Insufficient public spending on health.
  - Unequal access to health services.
- **Standard of Living:**
  - **GNI per Capita:** India's $6,397 is considerably lower than the world average of $18,513 (PPP).
  - **Comparison:** India's GNI per capita is surpassed by Sri Lanka ($18,765 (PPP)) and China ($17,730 (PPP)). (PPP stands for Purchasing Power Parity, meaning it takes into account differences in the cost of living across countries)
- **Challenges in Standard of Living:**
  - High levels of poverty and inequality.
  - Low participation of females in the labor force.
  - Ongoing environmental degradation.
  - India confronts disparities in education, health, and standard of living, necessitating focused efforts to address these challenges and enhance overall human development.

Gap between Economic and Human Development In India

According to IMF forecasts, India is poised to become the world's third-largest economy by 2030. However, its ranking of 132nd out of 191 countries and territories on the 2021-22 Human Development Index (HDI) highlights a disparity between human development and economic growth in the country.

- **Income Disparities:** Income serves as a measure of access to resources, including healthcare and education. Social disparities persist due to unequal income distribution.
- **Social Inequity:** India's diverse caste and communal divisions hinder social cohesion, impeding overall societal progress.
- **Gender Disparity:** Women in India face ongoing challenges in accessing education, healthcare, and economic opportunities due to gender-based discrimination and cultural norms.
- **Skill Development Deficiency:** Inadequate investment in skill development programs has led to a skills gap and reduced employability for many Indians.
- **Education Gaps:** While India's literacy rate is increasing, the education ministry reports that more than 1.2 million students were not enrolled in school in 2022-23, particularly at the elementary level. This is attributed to inadequate educational standards, insufficient infrastructure, gender disparities, and other factors.
- **Population Growth:** Rapid population growth strains resources and complicates efforts to improve human development indicators.
- **Low Government Spending:** Government expenditure on health and education remains low, standing at approximately 2.1% and 2.9% of GDP, respectively, compared to developed nations.
- **Infrastructure Gaps:** Insufficient infrastructure, both digital and physical, hinders connectivity, particularly with marginalized communities.
- **Top-Down Policy Approach:** India's historical reliance on top-down policy implementation has led to inefficiencies, corruption, and delays in reaching the intended beneficiaries, resulting in subpar human development outcomes.
- **Resource Mismanagement:** Despite mineral wealth in states like Jharkhand, inefficient utilization of resources hampers human development initiatives.
- **Healthcare Infrastructure Deficiency:** Inadequate investment in healthcare infrastructure has undermined efforts to improve overall human development outcomes.

The government has taken several steps to improve human development in the country:

- **National Education Policy 2020:**
  - Aims to **transform** the education system.
  - Focus on increasing **access, equity, quality,** and innovation.
- **Ayushman Bharat Scheme:**
  - Provides health insurance to **over 500 million** people.
  - Establishes primary health and wellness centers across the country.
- **Pradhan Mantri Jan Dhan Yojana:**
  - Facilitates **financial inclusion** and access to banking services.
  - Benefiting **over 400 million** people.
- **Swachh Bharat Mission:**
  - Aims for **universal sanitation** and hygiene.
  - Involves building toilets, improving **waste management,** and raising awareness.
- **National Rural Employment Guarantee Act (NREGA):**
  - Guarantees **100 days** of wage employment annually to rural households.
  - Focuses on creating assets for **rural development.**

These initiatives reflect the government's commitment to addressing key aspects of human development, including education, health, financial inclusion, sanitation, and rural employment.

Case Study- Nations with high HDI:

- **South Korea:** Achieved significant HDI growth through strategic investments in education, technology, and innovation.
- **Singapore:** Transformed into a high-income economy with a high HDI by prioritizing education, healthcare, and innovative economic policies.
- **Norway:** Maintains consistently high global HDI rankings through effective management of oil wealth, investments in education, healthcare, and a strong social welfare system.
- **China:** Lifted millions out of poverty, resulting in a substantial increase in HDI, driven by government investments in education, infrastructure, and poverty reduction.
- **Ireland:** Achieved notable HDI growth through economic development, education reforms, healthcare improvements, and a focus on foreign investment and innovation.

Multidimensional Poverty Index

The global Multidimensional Poverty Index (MPI) is an international measure of acute multidimensional poverty covering over 100 developing countries. It complements traditional monetary poverty measures by capturing the acute deprivations in health, education, and living standards that a person faces simultaneously.The global MPI was developed by Oxford Poverty & Human Development Initiative (OPHI) with the UN Development Programme (UNDP) for inclusion in UNDP's flagship Human Development Report in 2010. It has been published annually by OPHI and in the HDRs ever since.

Global MPI: dimensions and indicators of poverty

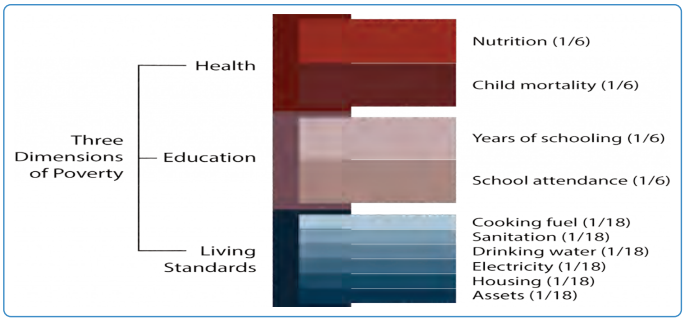


Fig. 7.14: Global Multidimensional Poverty Index

Significance of MPI

- **Individual-Level Assessment:**
  - MPI assesses poverty at the **individual level.**
  - Identifies individuals as **'MPI poor'** if deprived of a third or more of ten weighted indicators.
- **Measurement of Poverty Extent:** Measures the extent or intensity of poverty by calculating the percentage of deprivations individuals are experiencing.
- **Comprehensive Understanding:**
  - Offers a **comprehensive picture** of people living in poverty.
  - Shows who is poor, how they are poor, and the specific deprivations they face.
- **Global Applicability:**
  - Enables comparisons **across countries** and world regions.
  - Allows comparisons **within countries** based on various factors such as ethnic group, urban/rural area, subnational region, and age group.
- **Composition Analysis:**
  - Provides insight into the **composition of MPI** for each group and countries.
  - Illustrates the specific indicators contributing to poverty for different groups.

The MPI is a powerful tool for understanding and addressing poverty, offering detailed insights into its prevalence, intensity, and contributing factors at both global and local levels.

National MPI

India has developed its own national MPI, which is aligned with the global MPI but also customized to reflect the country's context and priorities. The **national MPI covers 12 indicators,** while the global MPI covers 10 indicators. The **two additional indicators in the national MPI are maternal health and bank account,** which are relevant for India's development goals. The national MPI is **calculated by NITI Aayog.**

Key Findings of National MPI 2023

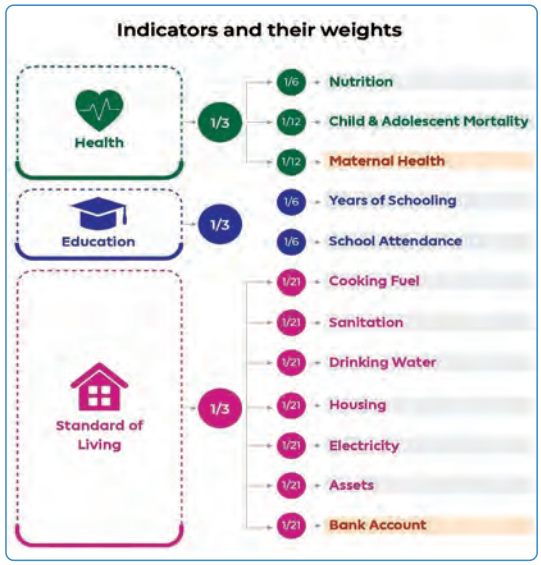


Fig. 7.15: National MPI

- **Overview:**
  - The **NITI Aayog** released the National Multidimensional Poverty Index (MPI) 2023 report.
  - Measures multidimensional poverty in India based on **health, education, and living standards** indicators.

- **Key Findings:**
  - India has **reduced multidimensional poverty** from 24.85% in 2015-16 to 14.96% in 2019-21.
  - Approximately **13.5 crore people** have been lifted out of poverty during this period.
- **Rural Areas Progress:**
  - **Fastest decline in poverty** is observed in rural areas.
  - States like **Bihar, UP, MP, Odisha, and Rajasthan** show significant improvements.
- **States with Low Poverty:** The number of states with less than 10% of people living in multidimensional poverty **doubled from 7 to 14** between 2016 and 2021.
- **Global MPI Reduction:**
  - India has made progress in reducing the **global MPI** aligned with the **Sustainable Development Goals (SDGs).**
  - Decreased from **55.3%** in **2005-06 to 14.9%** in **2019-21.**
- **Challenges Remain:** Despite progress, India faces challenges in improving indicators related to **nutrition, child and adolescent mortality, maternal health, and access to education.**

International Comparisons of Human Development

Contrary to expectations, size and income do not directly correlate with human development. Smaller and poorer nations often outperform larger and wealthier ones in HDI rankings.

- **Factors Influencing HDI:** The HDI accounts for non-income factors like health and education, favoring countries with better outcomes in these areas, such as Sri Lanka and Trinidad and Tobago outranking India.
- **Government Priorities in High HDI Countries:** Higher HDI nations prioritize education and healthcare, often former imperial powers with low social diversity, mainly located in Europe.

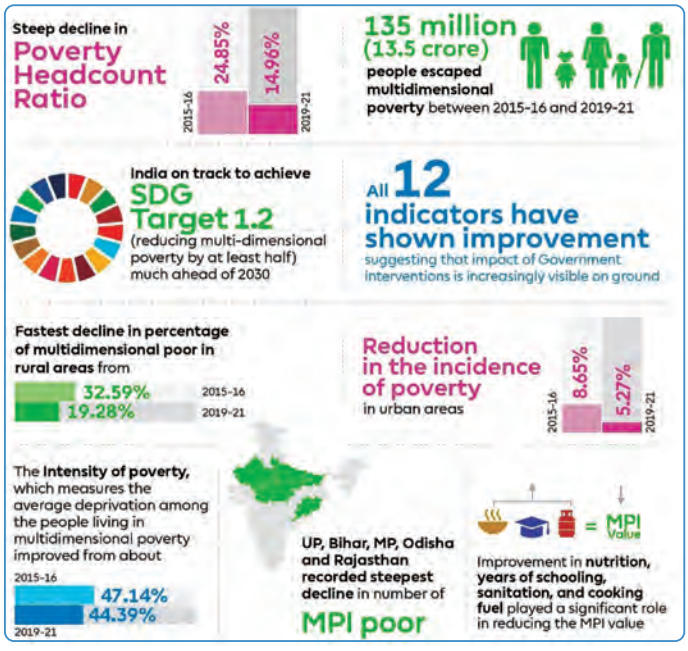

Steep decline in
Poverty Headcount Ratio
24.85%
14.96%
2015-16
2019-21
135 million (13.5 crore) people escaped multidimensional poverty between 2015-16 and 2019-21
India on track to achieve SDG Target 1.2
(reducing multi-dimensional poverty by at least half) much ahead of 2030
All 12 indicators have shown improvement
suggesting that impact of Government interventions is increasingly visible on ground
Fastest decline in percentage of multidimensional poor in rural areas from
32.59%
19.28%
2015-16
2019-21
Reduction in the incidence of poverty in urban areas
8.65%
5.27%
2015-16
2019-21
The Intensity of poverty, which measures the average deprivation among the people living in multidimensional poverty improved from about
47.14%
44.39%
2015-16
2019-21
UP, Bihar, MP, Odisha and Rajasthan recorded steepest decline in number of MPI poor
= MPI Value
Improvement in nutrition, years of schooling, sanitation, and cooking fuel played a significant role in reducing the MPI value

Fig. 7.16: International Comparisons of Human Development

- **Characteristics of Middle-level HDI Countries:** Emerging post-WWII or post-Soviet Union nations, rapidly improving their HDI with people-oriented policies and higher social diversity.
- **Challenges in Low HDI Countries:** Many low HDI countries face political turmoil, social instability, civil war, famine, or diseases, necessitating urgent policy interventions.

Blaming cultural factors for low HDI is misleading; human development levels are influenced more by government policies and social conditions than by cultural attributes.

WORLD DEVELOPMENT REPORT

- The **World Development Report (WDR)** is an **annual publication** by the **World Bank.**
- It examines the **economic, social, and environmental state** of the world and focuses on specific aspects like migration, poverty, education, health, and more.
- The reports provide **in-depth analysis, policy recommendations, and data** on various indicators of human development.
- **World Development Report, 2023:**
  - **Theme: "Migrants, Refugees, and Societies"**
  - **Objective:** Proposes an integrated framework to **maximize the development impacts** of cross-border movements on both destination and origin countries, as well as on migrants and refugees.
- **Key Findings of the Report:**
  - **Migration as a Challenge and Opportunity:**
    - Migration is viewed as both a **development challenge and an opportunity.**
    - Requires **international cooperation** and integrated policies.
  - **Drivers of Migration:**
    - Migration is driven by factors like **economic imbalances, demographic transitions, and climate change.**
    - Expected to be **increasingly necessary** in the future.
  - **Impacts of Migration:**
    - Migration has **positive and negative impacts** on destination and origin countries and migrants/ refugees.
    - Impacts vary based on the **type and motive** of the movement.
  - **Policy Recommendations:**
    - Proposes a **"match and motive"** matrix for migration policies, aligning migrants' skills with destination countries' needs and understanding motives.
    - Advocates addressing **protection needs of refugees and vulnerable groups** and dealing with social and political challenges of integration and inclusion.

SUSTAINABLE DEVELOPMENT

- **Definition:** Development entails transformative changes in societies, influenced by the interaction between human societies and their environment.
  - According to the Brundtland report, "Sustainable development is development that meets the needs of the present, without compromising the ability of future generations to meet their own needs."
- **Evolution:** Initially synonymous with economic growth, it expanded post-World War II to include equity, well-being, education, and political rights.
- **Multidimensional Approach:** Shaped by technology and institutions, development requires a multidimensional approach, encompassing economic, social, and material improvement.

Emergence of Sustainable Development :

- **Response to Environmental Concerns:** Fears of environmental degradation led to the establishment of the World Commission on Environment and Development **(WCED)** in 1983.
- **'Our Common Future':** The WCED's 1987 report, **'Our Common Future,'** defines **sustainable development** as meeting present needs without compromising the ability of future generations to meet their own needs.
- **Emphasis: Sustainable development** emphasizes ecological, social, and economic aspects, advocating for resource conservation for the benefit of future generations.

Interlinkage between Sustainable Development and Regional Planning:

- **Common Goals:** Both aim to achieve a balance between economic, environmental, and social goals for present and future generations.
- **Regional Planning Role:**
  - **Integration:** Regional planning integrates different sectors and stakeholders.
  - **Dimensions:** It addresses the spatial and temporal dimensions of development challenges.

Aspects of Interlinkage:

- **Localizing SDGs :**
  - **Definition:** Adapting and implementing the Sustainable Development Goals (SDGs) at local and regional levels.
  - **Benefits:** Improves regional planning, provides universally agreed targets, fosters partnerships.
  - **Alignment:** Regional planning aligns strategies with SDGs, mobilizes resources.
- **Economic Prosperity:**
  - **Regional Planning:** Organizes industries, commercial zones, and transportation networks strategically.
  - **Sustainable Development:** Encourages inclusive and environmentally responsible economic growth.
  - **Human Development:** Thriving economy enhances living standards, employment, education, and healthcare access.
- **Community Engagement:**
  - **Benefit:** Both benefit from community engagement in decision-making processes.
  - **Ownership:** Active community involvement fosters ownership and aligns plans with people's needs.
  - **Human Development:** Community engagement enhances social capital and well-being.
- **Integrated Approach:**
  - **Regional Planning:** Systematic organization of land use, infrastructure, and resources.
  - **Sustainable Development:** Integration of environmental, social, and economic factors for sustainable development.
  - **Resource Management:** Balances needs of the present while preserving resources for future generations.
- **Resource Management:**
  - **Regional Planning:** Addresses efficient use and conservation of natural resources.
  - **Sustainable Development:** Emphasizes responsible resource management for long-term ecological balance.
- **Social Equity and Human Development:**
  - **Regional Planning:** Considers social equity, addressing housing, transportation, and basic services.
  - **Human Development:** Focuses on improving individual quality of life.
  - **Contribution:** Regional planning creates inclusive environments for education, healthcare, and overall well-being.
- **Environmental Sustainability:**
  - **Sustainable Development:** Emphasizes environmental sustainability by minimizing negative impacts.
  - **Regional Planning:** Designs spaces promoting environmental conservation and resilience.
  - **Mitigation:** Integrated land-use planning mitigates environmental degradation, supports **sustainable practices**.

Conclusion

In this chapter, we explored the intricacies of regional planning, covering the concept and types of regions, addressing imbalances, and delving into principles and strategies. The discussion extended to India-specific aspects like Panchayati Raj, National Capital Region, and island territories. Transitioning to human development, the chapter dissected growth versus development, introduced the Human Development Index, and offered international comparisons through reports like the World Development Report 2023 and the Human Development Report.

This comprehensive exploration equips readers with insights into spatial dynamics and socio-economic well-being, guiding informed decision-making for sustainable development.

Agriculture and Irrigation

8

Agriculture is the practice of cultivating land and raising livestock to produce food and other products for human use. This encompasses activities such as planting and harvesting crops, raising animals for meat, milk, eggs, or fiber, maintaining soil fertility, controlling pests and diseases, and using irrigation to manage water.

Important Basic Terms Related to Agriculture:

- **Arable land:** Land suitable for growing crops, characterized by factors like soil quality, drainage, and climate.
- **Pasture:** Land covered with grass or other plants used for grazing animals, which can be natural or human-made.
- **Rangeland:** Extensive grassland areas used for grazing animals, particularly in drier regions, often managed by the government.
- **Cropland:** Land currently used to grow crops, distinguishing actively farmed land from fallow land not under cultivation.
- **Fallow land:** Land allowed to rest for a period to restore fertility, commonly practiced in organic farming.
- **Crop:** Any plant cultivated by humans for food, fiber, or other uses.
- **Crop Rotation:** The practice of growing different crops in the same area in sequential seasons to improve soil health, control pests and diseases, and optimize yields.
- **Agroforestry:** A land use system that integrates trees and shrubs with crops and/or livestock, combining agricultural and forestry practices to enhance sustainability and productivity.
- **Horticulture:** The science and art of growing fruits, vegetables, flowers, and ornamental plants, typically in gardens or small-scale farms.
- **Livestock:** Domesticated animals raised for meat, milk, eggs, wool, or labor, including cattle, sheep, goats, pigs, poultry, and others.
- **Fertilizer:** Substances applied to soil or plants to provide essential nutrients, such as nitrogen, phosphorus, and potassium, necessary for plant growth and productivity.
- **Pest Management:** Strategies and methods for controlling pests, including insects, weeds, and pathogens, to minimize crop damage and losses while minimizing environmental and health impacts.
- **Irrigation:** The artificial application of water to land for crop production, typically through channels, pipes, or sprinklers, to supplement natural rainfall and ensure adequate moisture for plant growth.

India holds a distinctive position in the global **agricultural** arena, with a substantial **45.6%** of its populace dependent on this sector which solidifies its status as the nation's economic backbone.

- **Exceptional Production Records:** Achieving world records in **agricultural** output, India boasts the largest cattle herd (buffaloes) and extensive cultivated areas for vital crops like **wheat, rice, and cotton**. The nation leads in the production of key commodities such as **milk, spices, pulses,** and secures the second-largest position for items like **fruits, vegetables, tea, aquaculture(farmed fish), cotton, wheat, rice, and sugarcane.**
- **Significant Employment Contribution: Agriculture** provides employment to almost **half** of the population, underscoring the pivotal role farmers play in the country's sustenance and prosperity. Beyond domestic needs, India's thriving **agricultural** sector plays a crucial role in global food production and security.

IN-DEPTH ANALYSIS OF INDIAN AGRICULTURE

Agriculture is the foundation of the civilization, culture and heritage of India and remains a cornerstone of the nation's economy.

- **Employment Dynamics:** Engaging **45.6%** of the workforce, this sector has seen a notable decrease from **72.1%** at Independence. Encompassing various activities, including **animal husbandry, horticulture, and crop cultivation.**
- **Crop Cultivation as the Backbone: Crop cultivation**, particularly in the **net sown area**, stands as the bedrock of Indian **agriculture**, dedicating **42.5%** of the country's land to this endeavor. Adoption of modern techniques becomes imperative to increase production per unit area, a necessity for catering to India's expanding population.

Economic Contributions of Indian Agriculture

- **GDP Significance:**
  - Consistently contributing **17-18%** to the **GDP**, Indian **agriculture** ranks among the world's highest, highlighting its economic prowess.
  - Higher proportion of Agriculture Workforce in total workforce distinguishes India from developed nations. Over **50%** of the workforce engaged in this sector differentiates India from developed nations.

- **Industrial and Trade Impacts:**
  - Fuelling industries like **sugar, jute, and cotton, agriculture** creates a substantial market for industrial products, fostering industrial growth.
  - Acting as a driving force in both domestic and international trade, it enhances the service sector and bolsters India's foreign exchange earnings.
- **Government Revenue and Labour Dynamics:**
  - Seasonal labour migration from **agriculture** to the urban unorganized sector is a common occurrence that further emphasises **agriculture's** pivotal role in labour dynamics.

Indian Agriculture Since Independence

Green Revolution and Government Interventions: Indian agriculture has undergone remarkable improvements since independence, largely attributed to the **Green Revolution** and proactive **government interventions**.

Surge in Food Grain Production

- The food grain production, which was merely 51 million tons (Mt) in 1950-51 increased over six times to over 314 Mt in 2022.
- This substantial rise has significantly impacted the nation's **food and nutritional security**, propelling India from a food-scarce nation in 1950 to a food-sufficient status by 2000, food-secured by 2010, and ultimately food-surplus from 2010 onwards.
- **Impactful Agricultural Transformation:** This transformation underscores the effectiveness of **policies, investments, and advancements** in agricultural practices implemented over the decades.

Role of Systematic Research in Agricultural Transformation

- **Imperial Council of Agricultural Research (ICAR):**
  - The establishment of the **Imperial Council of Agricultural Research (ICAR)** in 1929 marked a significant milestone.
  - Today, ICAR serves as the apex body for coordinating, guiding, and managing research and education in agriculture, including animal sciences and fisheries.
  - **Extensive Research Network:** ICAR oversees one of the world's largest **National Agricultural Research and Education Systems (NARES)**, comprising 113 research institutes, 74 agricultural universities, 4 deemed-to-be-universities, 3 central universities, and 731 **Krishi Vigyan Kendras (Agricultural Science Centers)** spread across the country.
- **Role of Investment in Occupational Structure**
  - **Capital-Intensive Industries:** A significant factor contributing to the stability of India's occupational structure is the directed investment towards **capital-intensive industries**.
  - This strategic investment approach has played a crucial role in shaping and sustaining the occupational landscape over the years

Production Of Agricultural Commodities And Cultivated Area In The Country In 1950-51 And 2021-22			
Commodity	**1950-51**	**2021-22**	**Relative Increment (Number of times)**
Food grains (Mt)	51	314	6.2
Vegetables & fruits (Mt)	25	333	13.3
Milk (Mt)	17	210	12.4
Egg (billion)	1.8	122	67.8
Fish (Mt)	0.8	14.2	17.8
Net sown area (Mha)	130	140	1.1
Gross sown area (Mha)	150	198	1.3

Indian agriculture has evolved from a focus on food grains to diversified crops, including rice, wheat, fruits, vegetables, and horticultural produce. It is a major contributor to employment and GDP but faces challenges such as water scarcity and climate change. The government is modernising agriculture through irrigation infrastructure, market access and technological advancements.

Indian Agriculture: Data-Wise	
Sector Overview	❑ Share in GVA in the year 2022-23 - 18.3 %. ❑ Average annual growth rate of 4.6 per cent during the last six years (3 per cent in 2021-22) ❑ Share in Total Employment is 45.5% in 2021-22.
Food Grain Production	❑ Wheat and Rice together accounted for around 75% of the food grains production (2022-23)

Present Status of Irrigation	❑ **Net Irrigated Area:** 49% of total Net Sown Area ❑ **Canal Irrigation (Public):** 25.7% ❑ **Wells and Tube wells (Private):** 63.9% ❑ **Tanks:** 5.8% ❑ 48% Of the Area Under Cultivation is Rainfed ❑ Rain-fed regions contribute to the production of approximately 90% of millets, 80% of oilseeds and pulses, along with 60% of cotton. These areas sustain nearly 40% of the population and provide support for 60% of the livestock.
Horticulture	❑ **Total Contribution to Agriculture GDP:** About 30.4% while using only 13.1% of the gross cropped area. ❑ Comprising nearly 90% of the entire horticultural output, fruits and vegetables position the industry as the second-largest global producer of these crops.
Livestock Sector	❑ **Livestock sector contribution to agriculture GDP:** 4.9% of GDP and 30.13% of total Agriculture GDP (2021-22).

CROPPING PATTERNS IN INDIA

Cropping patterns are indeed crucial elements of agriculture, and they play a significant role in shaping agricultural productivity and sustainability. A cropping pattern is characterised by the spatial arrangement of crop rotations or the specific list of crops cultivated in a given area, along with their chronological sequence over time. It takes into account various factors, including climate, soil conditions, water availability, market demand and farming practices.

Factors That Determine Cropping Pattern

- ❑ **Climate:** Prevailing climatic conditions, such as temperature, rainfall, and humidity, significantly influence crop selection for a particular region.
- ❑ **Soil Type:** Various soil types exhibit differences in nutrient levels, water retention capabilities, and drainage characteristics, which significantly influence crop suitability and choice.
- ❑ **Water Availability:** Water resources' accessibility, whether from irrigation infrastructure or precipitation patterns, is a vital factor in deciding which crops to cultivate and understanding their specific water needs.
- ❑ **Market Demand:** Farmers consider market demand and prices for various crops when deciding what to cultivate, ensuring the profitability and marketability of their produce.
- ❑ **Farming Practices:** Local or traditional farming practices, as well as the availability of machinery, equipment, and labour, influence cropping patterns.
- ❑ **Farm Size:** The size of the farm and the availability of resources to the farmer affects the feasibility of adopting particular crop patterns.
- ❑ **Government Policies:** Government policies, subsidies and assistance directed towards specific crops can shape farmers' choices and have a substantial impact on the prevailing cropping patterns within a region.
- ❑ **Crop Suitability and Yield Potential:** While determining cropping patterns, crucial considerations include the suitability of crops to local conditions and their anticipated yield potential in a given region.

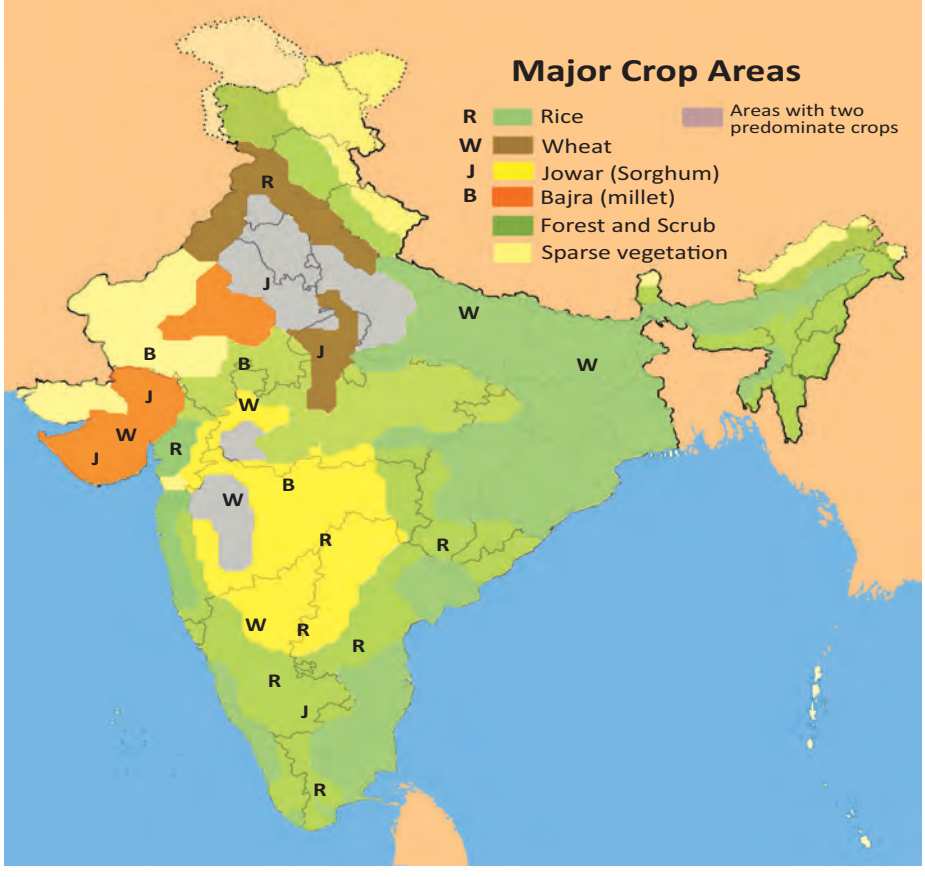


Fig. 8.1: Major Crop Areas in India

- **Pest and Disease Management:** The prevalence of pests and diseases in a region can influence crop choices and the need for strategies like crop rotation or intercropping to manage these challenges.
- **Farmer's Knowledge and Experience:** The knowledge, skills, and experience of farmers in a particular region also play a crucial role in crop selection and cropping patterns.
- **Technology and Farm Mechanization:** The level of technological advancement and the availability of farm machinery influence the cropping pattern. Modern technologies, such as drip irrigation or precision farming, can enable the cultivation of certain crops that may not have been feasible in the past.
- **Crop Rotation and Soil Health:** Farmers often practise crop rotation to maintain soil fertility and prevent soil degradation. The need to maintain soil health can influence the choice of crops in a particular sequence.
- **Crop Diversity and Risk Management:** Diversification of crops can help farmers manage risks associated with weather fluctuations, pests, and market uncertainties. Growing a variety of crops provides a form of insurance against unforeseen challenges.
- **Cultural and Social Factors:** Local customs, traditions, and cultural preferences can also impact cropping patterns. Certain crops may have cultural significance, and farmers may continue to cultivate them due to social or traditional reasons.

Issues with Current Cropping System

- **Traditional Methods:** Agricultural practices in India have achieved self-sufficiency but remain resource-intensive, focused on cereals, and exhibit regional biases. These shortcomings raise concerns about the sustainability of current methods.
  - Farmers may resist changes due to traditional practices and lack of awareness.
- **Unsustainability Concerns:** With over half of India's population relying on rural employment, the slow growth in agriculture is a pressing concern for the policy-makers. The existing practices lack both economic and environmental sustainability.
- **Cereal Dominance:** Cereal crops (rice, wheat, maize, millet, sorghum and barley) dominate the food crop landscape, covering approximately 52% of the cultivated area. This dominance is attributed to better prices, lower production risks, and the availability of improved seeds.
- **Decline in Coarse Cereals:** Nutri cereals like Jwar, Bajra, Maize, Millets, and Barley, categorised as coarse cereals, have witnessed a significant decline in cultivation.
  - The proportion of area under these crops has decreased from 48% in 1950-51 to around 29% in 2001. Factors contributing to this decline include the expansion of irrigation facilities, improved inputs, and changing consumption patterns.
- **Infrastructure Gaps:** Inadequate infrastructure for storage, transportation, and processing hinders can hinder the adoption of new cropping patterns.
- **Market Risks:** Fluctuations in market demand and prices pose risks for farmers transitioning to new crops.
- **Limited Access to Credit:** Financial constraints may limit farmers' ability to invest in new crops and technologies.
- **Social Changes:** Agriculture is undergoing notable social changes, including increased feminization due to a rise in women-headed households. There is also a surge in rural-urban migration by men and a shift toward labour-intensive cash crop production.

IGNITE YOUR MIND

Crop Diversification: Rice is India's staple, but it's water-intensive. While millets offer nutrition and climate resilience. Can we diversify crops without compromising food security? How can we protect and enhance biodiversity while ensuring food production?

Changes in Cropping Pattern in India

A. Changing Consumption Patterns Impacting Cropping pattern:

- **Increase in Protein Demand:** The rising demand for protein-rich food has led to an expansion of soybean cultivation.
- **Growing Meat and Dairy Demand:** The increasing preference for meat and dairy products has driven the cultivation of commercial fodder crops.
- **Preference for Chemical-Free Food:** The shift towards organic and natural farming has gained momentum due to consumer preferences for chemical-free food.
- **Focus on Nutritious Food:** The emphasis on more nutritious food choices has contributed to an expansion in the cultivation of horticulture crops.
- **Demand for Exotic Food:** The increasing demand for exotic foods has fueled the growth of hydroponics and aeroponics crops.
- **Increased purchasing power:** leading to increase in demand of fruits and vegetables which is evident from horticulture produce overtaking cereal production for the first time in last few year.

B. Changing Market Conditions Influencing Cropping:

- **Export Push:** The push for export-oriented agriculture has led to increased cultivation of high-value crops.
- **Food Processing Demand:** The rise of Farmer Producer Organizations and cooperatives has steered

cropping patterns toward commercial crops to meet the demand for food processing.

- **Cobweb Phenomena:** Market demands in one year influence the cropping pattern of the next year, particularly for TOP (Tomato, Onion, Potato) crops.
- **Subsidies Impact:** Subsidies, particularly under Minimum Support Price schemes, influence cropping patterns by favouring certain crops.
- **e-Marketplace Impact:** Farmers connecting with nationwide e-marketplaces have aligned cropping patterns with broader market forces, extending beyond local demands.
- **Contract Farming and Value Chains:** Contract farming arrangements with agribusiness firms have encouraged farmers to shift towards crops with assured markets, including cotton, sugarcane, and specific horticultural products.

These shifts highlight the dynamic interplay between changing consumer preferences and evolving market dynamics, influencing the agricultural landscape.

Way Forward

- Aligning cropping patterns with consumption trends and market conditions is imperative which should be coupled with the adoption of sustainable and resilient agricultural practices.
- A holistic approach involving coordinated efforts from government, farmers, and stakeholders is essential for a successful transition to improved cropping patterns.
- Addressing challenges, promoting sustainable practices and leveraging technological advancements can pave the way for a resilient and diversified agricultural sector in India.

TYPES OF FARMING IN INDIA

India has several types of farming based on factors like rainfall, irrigation, purpose, ownership, and technology. Major types of farming are explained in brief below:

Type of Farming	Description	Key Regions	Important Crops
Dry Farming	Cultivation of crops in areas where rainfall is less than 750 mm per annum. Relies on seasonal rainfall. Only one crop grown per year due to limited moisture. Farmers engage in subsidiary activities like dairy farming.	Rajasthan, Maharashtra, parts of Madhya Pradesh, southern Haryana, Gujarat, Karnataka	Millets (jowar, bajra, ragi)
Wet Farming	Practised in regions with abundant alluvial soils and high annual rainfall (>200 cm). Supports multiple crops in a year.	West Bengal, Assam, Nagaland, Meghalaya, Tripura, Manipur, Mizoram, parts of Malabar coast	Rice, jute
Irrigated Farming	Practised in regions with moderate annual rainfall (80-200 cm). Access to water from underground sources, rivers, tanks, and lakes throughout the year.	Punjab, Haryana, Uttar Pradesh, northwestern Tamil Nadu, deltas of peninsular rivers	Wheat, rice, sugarcane
Subsistence Farming	Aimed at meeting local needs. Characterised by small landholdings, manual labour, and simple farm implements.	Parts of Chhattisgarh, Uttarakhand, Jharkhand, hilly areas across the country	Various local crops for self-sustainability
Shifting Cultivation	Farmers clear land by cutting and burning forests, then grow crops for a few years until fertility declines. In the Northeast, known as "Jhuming."	North-east India, tribal belts in Orissa, Chhattisgarh, Andhra Pradesh	Various crops for subsistence
Terrace Cultivation	Practised in hilly areas. Farmers carve out terraces on hill slopes to conserve soil and water.	Himalayan region, hills of the peninsular region, northeastern states	Various crops suited for terraced cultivation
Plantation Agriculture	Well-organised cultivation of a single crop on a large scale. Requires significant investment.	Assam, West Bengal, Nilgiri hills slopes	Tea, coffee, rubber
Commercial Farming	Farmers grow crops primarily for the market. Raw materials for industries. Examples: sugarcane (Uttar Pradesh, Maharashtra), cotton (Maharashtra, Gujarat, Punjab), jute (West Bengal).	Uttar Pradesh, Maharashtra, Gujarat, Punjab, West Bengal	Sugarcane, cotton, jute

Contract Farming	Agreements between companies and farmers for the production and supply of agricultural products. Companies provide facilities, buy back products at predefined rates.	Popular in Punjab with companies like Pepsi and McDonald's.	Fruits, vegetables
Eco-Farming	Also known as organic farming. Avoids synthetic fertilisers, pesticides, livestock feed additives. Relies on methods like crop rotation, crop residues, animal manure, biological pest control.	Rajasthan, Andhra Pradesh, Madhya Pradesh, Pondicherry, Punjab	Various organic crops

RECENT DEVELOPMENTS IN THE AGRICULTURAL SECTOR

The government has created the **Food Processing Fund (FPF)** with approximately rs 2000 crore, housed within the National Bank for Agriculture and Rural Development (NABARD).

- This initiative aims to offer accessible credit to approved food parks and the processing enterprises operating within these parks. The food processing industry has received FDI inflow worth $12,354 Mn from April 2000 to September 2023.
- In 2022, the Indian government launched **Kisan Drones** for various agricultural applications, including crop assessment, digitization of land records, and the efficient application of insecticides and nutrients.
- Exports of agricultural products (including marine and plantation products) for the year 2021-22 crossed USD 50 billion, highest level ever achieved for agriculture exports.
- In October 2022, the Prime Minister inaugurated the **PM Kisan Samman Sammelan 2022** and disbursed **PM-KISAN Funds** amounting to Rs. 16,000 crore (approximately $1.93 billion).
- Additionally, a **Special Food Processing Fund** of Rs. 2,000 crore (about $242.72 million) was established in collaboration with the National Bank for Agriculture and Rural Development (NABARD) in August 2022 to provide accessible credit for investments in Mega Food Parks (MFPs) and processing units within these parks.
- In August 2022, the Minister of Agriculture and Farmers Welfare inaugurated four new facilities at the **Central Arid Zone Research Institute (CAZRI),** an institution that has been serving for over six decades under the Indian Council of Agricultural Research (ICAR).
- Furthermore, **Nestle India** is gearing up to invest Rs. 700 crore (approximately $85.16 million) in constructing its ninth factory in Gujarat. According to the economic survey for 2022-23, a substantial allocation of Rs. 13,681 crore (approximately $1.6 billion) was made for Post-Harvest Support and Community Farms under the Agriculture Infrastructure Fund.
- **Private investment** in agriculture increased to 9.3% in the fiscal year 2020-21. Institutional credit provided to the agricultural sector continued to grow, reaching Rs. 18.5 lakh crore (approximately $226 billion) in the fiscal year 2022-23.

MAJOR CROPS

The major crops of India can be grouped under Cereals,Pulses, Millets, Oil seeds, Plantations, Spices etc. Each of these have been dealt in detail in the following:

Food Grains

The significance of foodgrains in the Indian agricultural economy is evident as these crops cover approximately **two-thirds of the total cropped area** in the country. Foodgrains

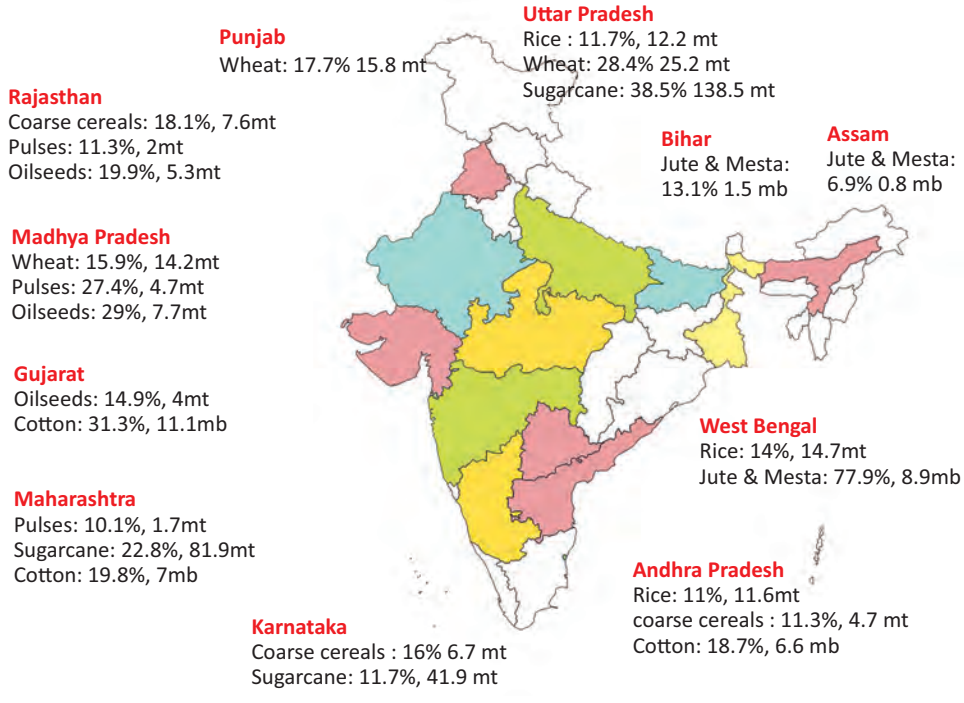


Fig. 8.2: Major States and their Crops Production for 2014-15 (mt = Million Tonnes & mb = Million Bales for Textiles)

play a dominant role in both subsistence and commercial agricultural economies across all regions. Based on the grain structure, **foodgrains are categorised into cereals and pulses.**

Cereals

Cereals are a cornerstone of Indian agriculture, with a significant portion of the country's cultivated land dedicated to their production. India leads in pulse production. Cereals account for about 54% of India's gross cropped area and approximately 11% of the world's total cereal production. India cultivates a diverse range of cereals, categorised into:

- **Fine grains** such as rice and wheat, and
- **Coarse grains** like jowar, bajra, maize, ragi, and others.

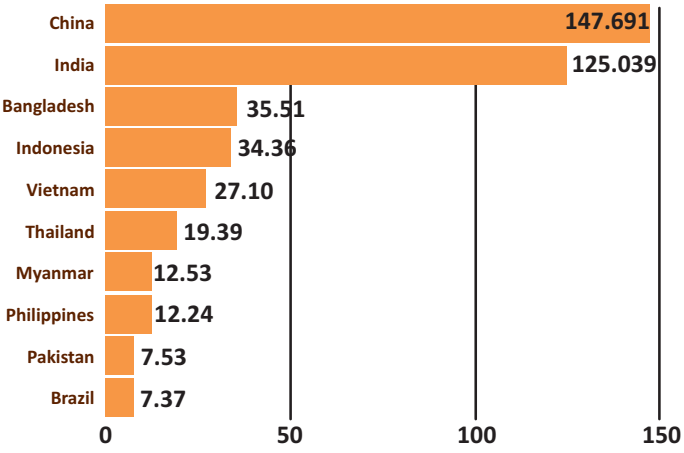


Fig. 8.3: Rice Production of Top 10 Countries (in Million Tonnes)

Some of the key cereals grown in India are as follows:

Rice

Rice cultivation thrives in regions characterised by a hot and humid climate, ideally with abundant humidity, extended periods of sunshine, and a reliable water source. The crop requires an average temperature ranging from 21 to 37°C throughout its growth cycle, with a maximum tolerance of 40°C to 42°C.

- Despite being classified as a crop suited for tropical humid regions, it boasts around 3,000 varieties cultivated across diverse agro-climatic zones. Rice is cultivated in a range of climates, from flooded fields (paddy fields) to rainfed upland areas.
- ˇThe rice planting process involves initially sowing paddy seeds in nurseries. After 25-35 days, these seedlings are uprooted and transplanted into the main field. Nursery sowing typically takes place before the onset of monsoon rains. In the initial three weeks following transplanting, the water depth needs to be kept at 4-5 cm to manage weed growth in the early stages of the crop.

World Scenario in Rice cultivation

The two main types of rice, **indica and japonica**, have different preferences for growing conditions.

- **Top Rice Producing Countries:** China and India are the top two producers of rice globally, with other Asian countries like Indonesia, Bangladesh, Vietnam, and Thailand also contributing significantly. In **Africa**, Nigeria and Egypt are among the leading producers.

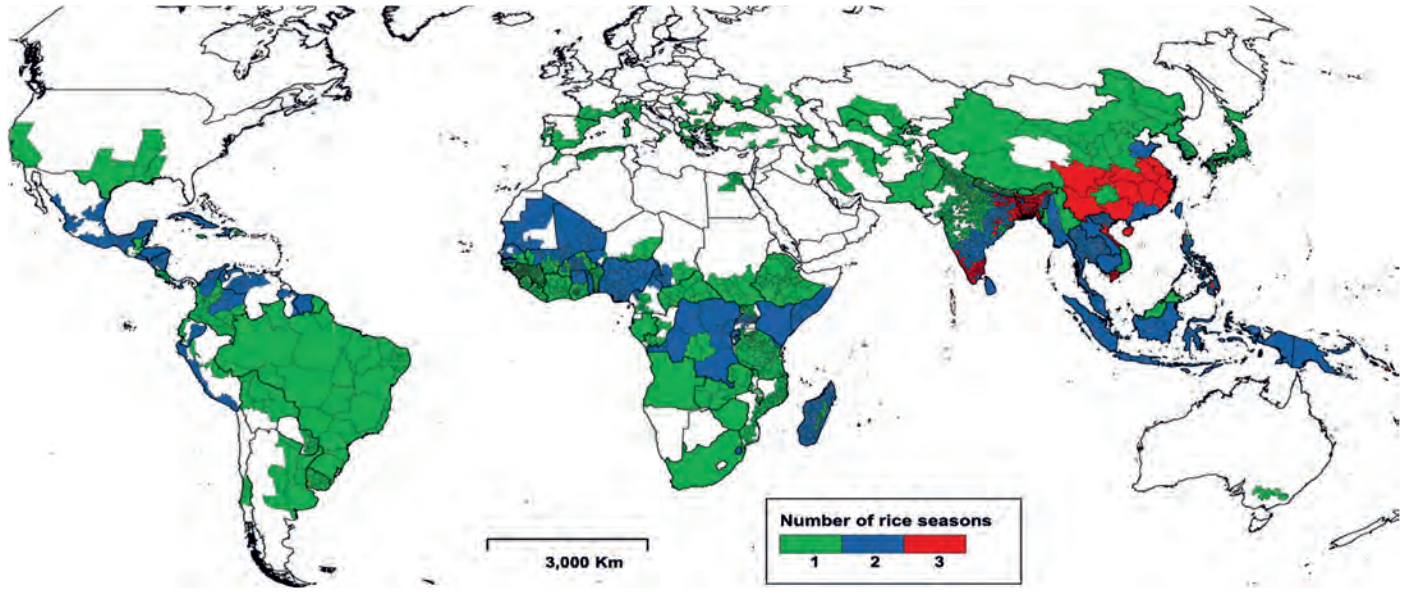


Fig. 8.4: RIce growing regions of the world

India's scenario in Rice Cultivation

- Rice is a staple food crop of India, primarily grown in the tropical humid regions. Kharif rice production in FY23 reached 110.032 million tonnes, according to the third advance estimate provided by the Agriculture Ministry.

- The traditional rice-growing regions are in eastern and southern India, where conditions allow for two to three rice crops per year. However, the development of irrigation has expanded rice cultivation to areas like Punjab, Haryana, western Uttar Pradesh, and northern Rajasthan.
- **India is the second-largest rice producer** globally, contributing around 21.5% of the world's total rice production. India is the **world's biggest exporter** (accounting for about 40% of the world's export).
- The **major rice-producing states** in the descending order are West Bengal, Uttar Pradesh, Punjab, Tamil Nadu and Andhra Pradesh.
- **Prominent varieties:** Krishna, Sabarmati, IR-8, Jaya, Padma, Hamsa, and IET 1039.
- **Aus, Aman and boro** are three types of rice varieties grown in Assam, West Bengal and Odisha.
- One-fourth of arable land is used for rice cultivation in India.
- **Concern about Climate Change:** Rice is an anthropogenic source of both methane and nitrous oxide.

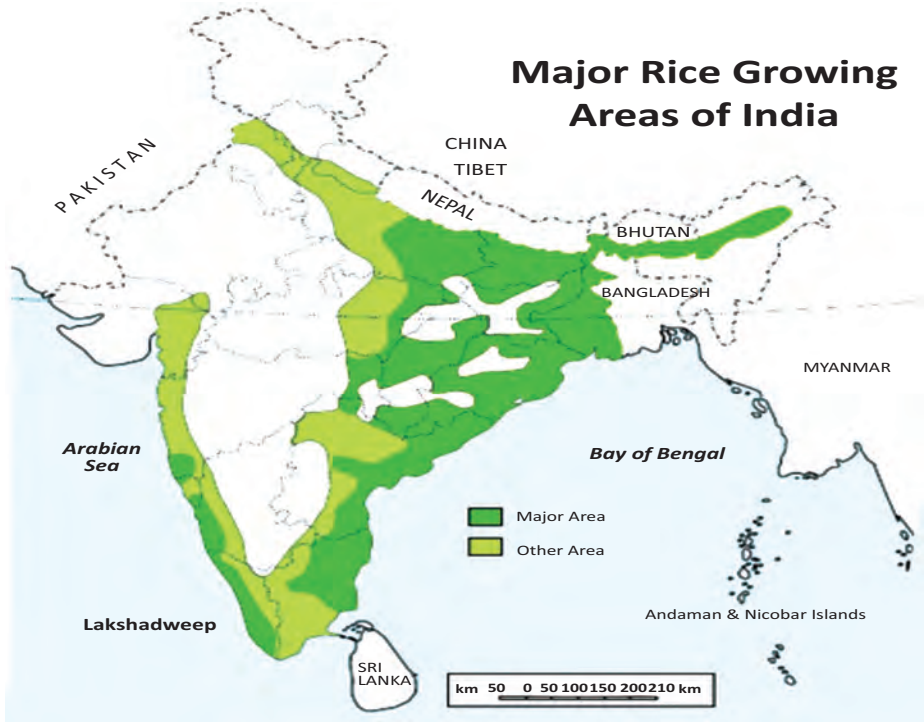


Fig. 8.5: Rice Producing states in India

System of Rice Intensification

The System of Rice Intensification (SRI) is an innovative method of rice cultivation focused on sustainable and resource-efficient practices. It involves transplanting young rice seedlings, maintaining wider spacing, and using controlled irrigation with intermittent drying to encourage root growth. Weeding is done mechanically, reducing the need for herbicides. Incorporating organic matter into the soil, crop rotation, and aeration methods are key components.

The System of Rice Intensification (SRI) offers a range of benefits for rice cultivation. It enhances yields by promoting healthier root and plant development, reduces water usage significantly, lowers the need for chemical inputs, improves soil structure and fertility, minimises methane emissions, increases farmer income, and promotes sustainable and eco-friendly farming practices, contributing to food security and environmental conservation.

Direct Seeding of Rice (DSR)

Transplanting paddy involves sowing seeds in nurseries, uprooting, and replanting in the main field. In contrast, Direct Seeding of Rice (DSR) involves drilling pre-germinated seeds directly into the field without nursery preparation. DSR saves water, and labour, and reduces methane emissions but requires more seeds, herbicide use, and laser land levelling. While transplanting uses water to control weeds, DSR relies on herbicides. Timely sowing is crucial for DSR before monsoon rains.

Kuttanad Below-Sea-Level Farming

Kuttanad, in Kerala, India, practises unique below-sea-level farming called "polder farming." It involves dividing fields with earthen bunds to prevent saltwater intrusion. The primary crop is "pokkali" rice, a salt-tolerant variety. Farming alternates between wet and dry seasons. Pokkali farming is organic, using natural nutrients from backwaters. Integrated farming combines rice with shrimp and fish cultivation. Despite its cultural significance, Kuttanad faces challenges from climate change, salinity, and rising sea levels, necessitating sustainable practices and infrastructure development.

Wheat

Wheat is the second most important cereal crop in India, following rice. It is a temperate crop primarily grown during the Rabi season in northern and central states, including parts of the Himalayan region.

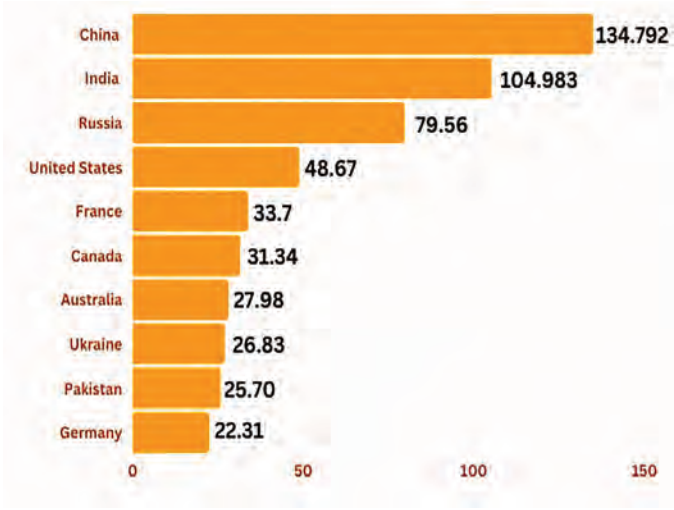


Fig. 8.6: Major Wheat Producing countries and their production in Million Tonnes (Based on 5 year average between 2018-19 and 2022-23)

- The optimum temperature range for ideal germination of wheat seed is 20 to 25°C though the seeds can germinate in the temperature range of 3.5 to 35°C. Wheat plant requires about 14-15°C optimum average temperature at the time of ripening. Temperatures above 25°C during this period tend to depress grain weight. It thrives in regions receiving **50 to 75 cm** of rainfall and prefers well-drained, fertile soil.
- Wheat also benefits from a cool growing season and abundant sunshine during the ripening stage. Wheat cultivation relies heavily on irrigation, except in rain-fed regions. **India is the second-largest wheat producer globally,** contributing around **13%** of the world's total wheat production.

Wheat cultivation - World Scenario

Wheat covers a larger land area than any other food crop, with 217 million hectares (536 million acres) dedicated to its cultivation in 2021. Additionally, global trade in wheat surpasses that of all other crops combined.

- In 2022-23, according to the International Grains Council, China, India and Russia are the top 3 producers of Wheat, whereas Russia, Canada and the United States are the top 3 exporters of wheat.
- Ukraine is called the "**breadbasket of the world**," due to extensive production of food grains like Wheat, Barley in its vast fertile lands. It is among the top 10 wheat exporting nations.

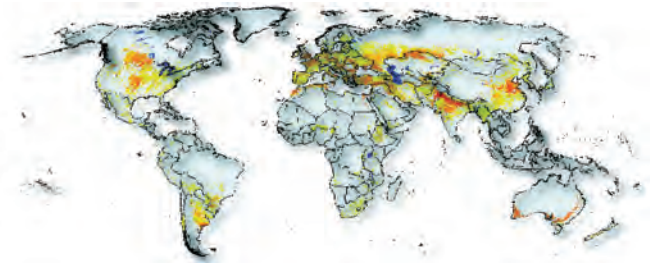


Fig. 8.7: Wheat growing regions of the world

Wheat cultivation - Indian Scenario

- Uttar Pradesh comes out on top of the list and is the largest wheat-producing state in India followed by Madhya Pradesh, Punjab, Haryana and Rajasthan.

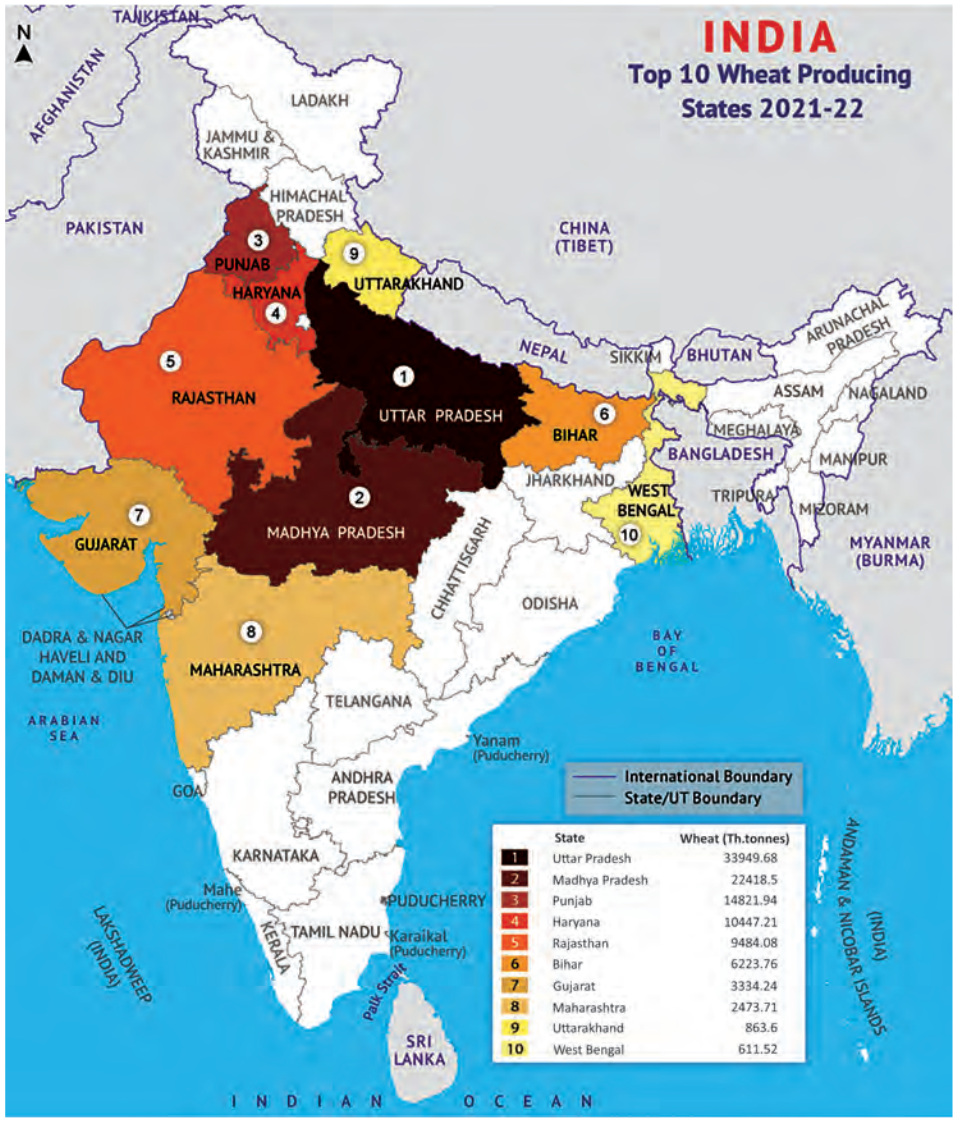


Fig. 8.8: Major Wheat Producing states in India

Wheat cultivation in India has historically been concentrated in the northern region. The country has a total wheat cultivation area of approximately 29.8 million hectares.

- According to the **Second Advance Estimates for the agricultural year 2022-23**, wheat production is estimated at 112.18 million tonnes. This represents an increase of 4.44 million tonnes compared to the previous year's production in 2021-22.

Yellow Rust Disease in wheat: Yellow rust, also known as stripe rust, is a fungal disease that impacts wheat crops by creating yellow stripes on the leaves, disrupting their photosynthesis process and leading to a reduction in grain size.

This disease primarily occurs in cooler weather conditions, particularly in the northern hills and northwestern plains zone. Favourable conditions for yellow rust include slight rain, a slight temperature rise, and increased humidity in the region.

Maize

Maize thrives in temperatures ranging from 18°C to 27°C during the day, with night-time temperatures around 14°C. However, the crucial factor for successful cultivation is the availability of at least 140 frost-free days. Maize is highly vulnerable to frost, which limits its cultivation in temperate regions with cold climates.

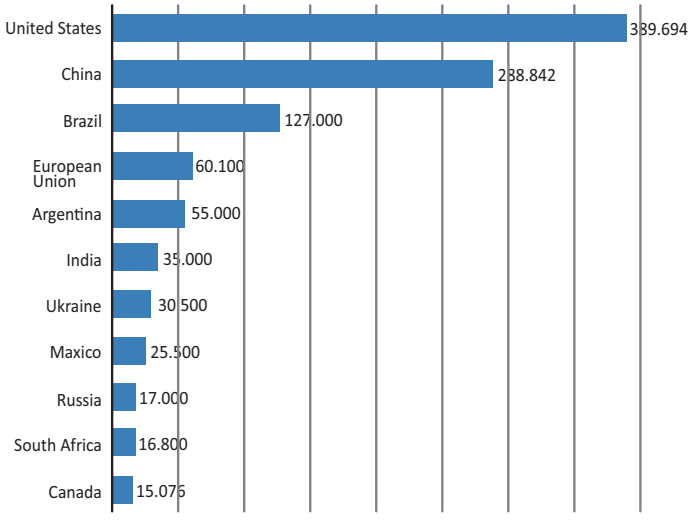


Fig. 8.9: Major Maize producing countries of the world 2023-24(estimate)

Maize cultivation - World Scenario

- Maize and cornmeal (ground dried maize) are staple foods in various parts of the world. Cornstarch, derived from maize, is a common ingredient in home cooking and processed foods.
- Maize starch can be processed to produce syrups, including high-fructose corn syrup. Corn flour is used for making cornbread and other baked goods.
- In Mexican cuisine, maize is a key ingredient in dishes like tacos, quesadillas, chilaquiles, enchiladas, tostadas, tortillas, tamales, pozole, and atole.
- Additionally, coarse cornmeal is often cooked into a thick porridge in many cultures.
- In 2021, the **top exporters** of Corn were the United States ($18.8B), Argentina ($8.88B), Ukraine ($5.86B), Brazil ($4.44B), and France ($1.92B).

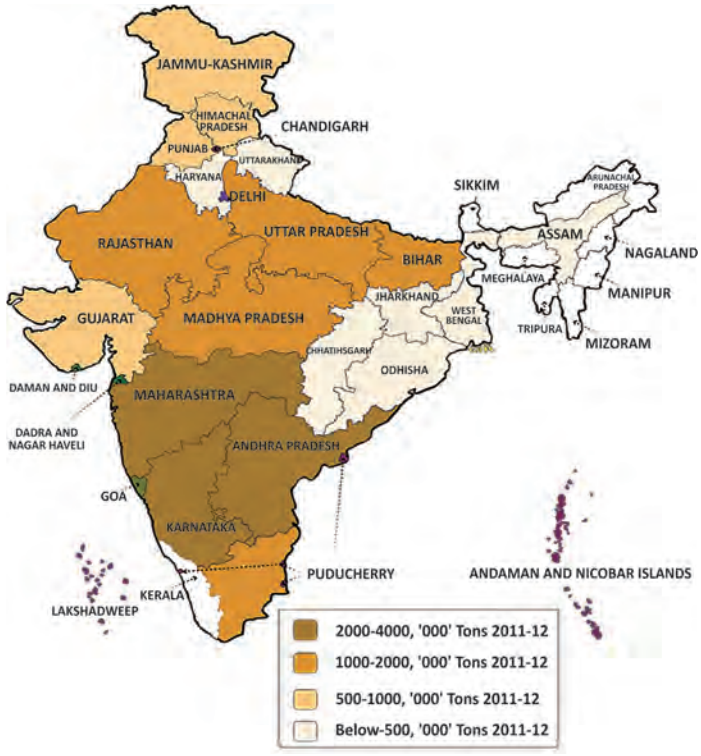


Fig. 8.10: Top maize producing states in India

Maize cultivation - Indian Scenario

- In India, maize is the 3rd most important food crop after rice and wheat. It is cultivated across 11.3 million hectares of land (as of 2012-13) under various agro-ecological conditions. Maize plays a significant role in the country's food production, contributing nearly 8% to the national food supply.
- Maize cultivation in India has seen an increase in both area and production. Improved varieties and increased irrigation have contributed to a more than five-fold increase in maize production.
- Maize is grown all over the country, except in eastern and northeastern regions. Key maize-producing states include Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, Telangana, Andhra Pradesh, Rajasthan, Uttar Pradesh, and West Bengal. Maize is cultivated under semi-arid conditions and in areas with inferior soils, serving as both a food and fodder crop.

- A significant portion of maize production in India, around 47%, is utilised as poultry feed. The remaining share is distributed as follows: 13% for livestock feed and 13% for food purposes each, 12% for industrial applications, 14% in the starch industry, 7% for processed food, and 6% for export and other uses.

Millets (Shree Anna)

India holds a substantial **19%** share in global millet production, with **Pearl Millet (Bajra)** at **40.51%** and **Sorghum (Jowar)** at **8.09%.**

- India, Nigeria and China are the largest producers of millets in the world, accounting for more than 55% of the global production.
- The African region has witnessed a remarkable surge in millet cultivation.
- The top millet-producing states include Rajasthan, Maharashtra, Gujarat, Karnataka, Uttar Pradesh, Haryana, Madhya Pradesh, Andhra Pradesh, Tamil Nadu and Uttarakhand, accounting for 98% of India's millet production in 2020-21.

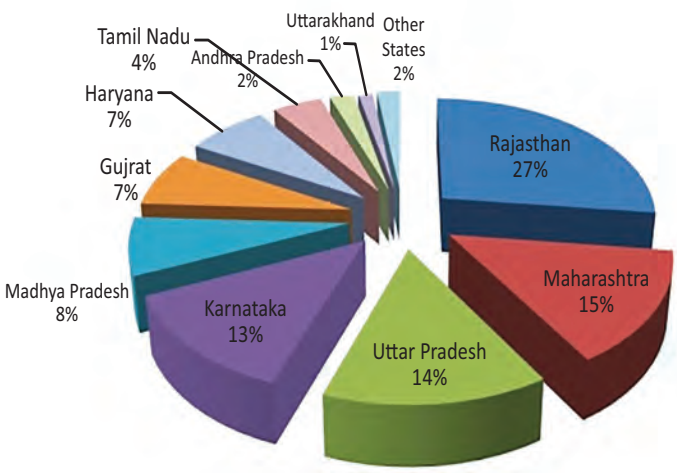


Fig. 8.11: State-wise Millet share 2021-22

A. Sorghum (Jowar): A Crucial Crop in Dryland Agriculture

- Cultivating an annual area of **17-18 million hectares,** Sorghum (Jowar) yields **8-10 million tonnes.**
- Predominantly grown in peninsular and central India, covering states like **Maharashtra, Gujarat, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, Karnataka, Rajasthan,** and **Tamil Nadu.**
- Dual-purpose crop for human consumption (roti/bhakri) and essential cattle fodder.
- Thrives in diverse climates, ranging from arid to humid regions, with an optimal temperature range of **15°C to 40°C,** and an annual rainfall between **400 to 1000 mm.**
- Prefers clayey loam soil with a pH range of **5.5 to 8.0.**

Pearl Millet (Bajra): Drought-Tolerant Crop

- Thriving in dry and warm climates, Pearl Millet (Bajra) is recognized for its exceptional drought tolerance.
- Well-suited for regions with low annual rainfall, typically ranging from **50 cm to 60 cm.**
- Flourishes within an ideal temperature range of **20°C to 30°C.**
- Despite a reduction in cultivation area, production has nearly tripled.
- Main cultivation areas encompass drought-prone regions in **Rajasthan, Uttar Pradesh, Gujarat, Haryana,** and **Maharashtra.**

B. Finger Millet (Ragi): A Staple Crop

- Extensively cultivated across **2.5 million hectares** in states like **Karnataka, Tamil Nadu,** and **Andhra Pradesh,** yielding approximately **2.2 million tonnes annually.**
- Ragi plants thrive in diverse conditions, with varying spike lengths and grain colors.
- Cultivated throughout the year, both in hot and cold seasons, offering rainfed yields of **10 to 15 quintals per hectare** and irrigated yields of **40 to 50 quintals per hectare.**
- Requires daytime temperatures of **30°C to 34°C,** night temperatures of **22°C to 25°C,** and an optimal annual rainfall of approximately **100 cm.**
- Flourishes in a wide range of soils, with a pH level for optimal growth between **4.5-7.5.**

C. Barley

- India produced approximately **1.67 million metric tons** of barley in the fiscal year 2021.
- Suited for subtropical climates, demanding temperatures around **12-15°C during the growing season and about 30°C at maturity.**
- Main cultivation states include **Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan, Punjab, Haryana, Bihar, West Bengal,** and **Jammu Kashmir.**
- Occupies nearly **0.78 million hectares,** with a per-hectare productivity of **19.74 quintals.**
- Suitable soils encompass sandy loam, loam and medium to heavy black soils, preferably with neutral to saline characteristics and medium fertility.

IGNITE YOUR MIND

Superfood Stardom or Sustainability Sham? Certain crops like quinoa are marketed as "superfoods," fetching higher prices. Are these trends truly sustainable and beneficial for all farmers?

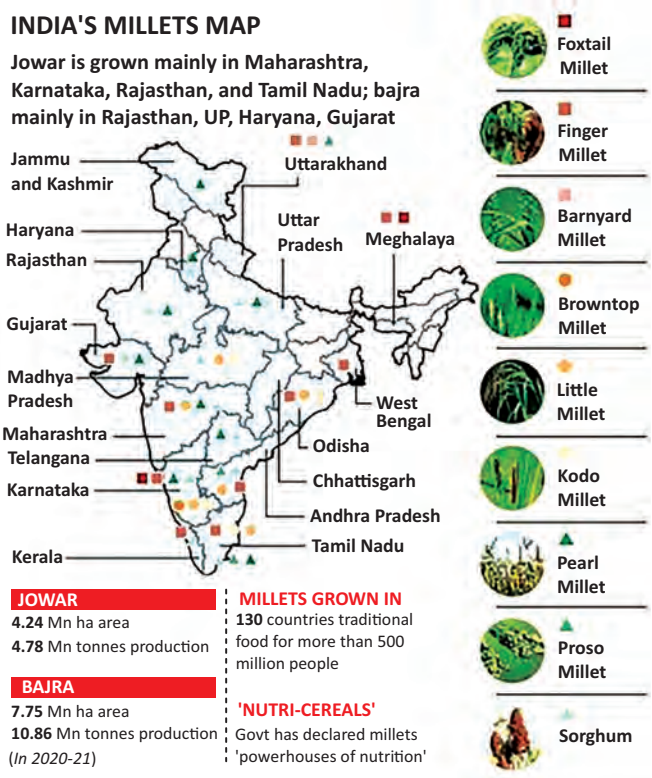


Fig. 8.12: Millet Map of India

Do you know?

International Year of Millets-2023: Millets, an enduring part of our diet, offer numerous health benefits and boast low water and input requirements which makes them environmentally friendly. In response to the Government of India's efforts, the **United Nations** has declared 2023 as the International Year of Millets to raise awareness and promote increased production and consumption of these nutritious grains.

- India produces more than 50.9 million tonnes (as per fourth advance estimate) of millet which accounts for 80 per cent of Asia's and 20 percent of global production.
- The global average yield is 1229 kg/ha, whereas India has a higher average yield of 1239 kg/ha. Given the nutritional value of the millets, the Government notified Millets as Nutri-cereals in April 2018.
- Under the National Food Security Mission (NFSM), millets have been introduced to provide nutritional support. A sub-mission on Nutri-cereals is being implemented from 2018-19 in 212 districts of 14 States.
- India has more than 500 start-ups working in the millet value chains, while the IndianInstitute of Millets Research has incubated 250 start-ups under **Rashtriya Krishi Vikas Yojana – Remunerative Approaches for Agriculture and Allied Sectors Rejuvenation (RKVY RAFTAAR)**.

Advantages of Millet Cultivation

- **Climate-Resilient Staple Food Crops:** Millets exhibit drought resistance, thrive with minimal water, and can flourish in poor soil conditions, making them well-suited for regions with unpredictable weather and water scarcity.
- **Nutrient-Rich:** Millets are a rich source of fibre, protein, vitamins, and minerals, contributing to a nutritious diet.
- **Gluten-Free:** Naturally gluten-free, millets are a suitable choice for individuals with celiac disease or gluten intolerance.
- **Adaptability:** Millets can be cultivated in diverse soils and climates, showcasing their versatility as a crop option for farmers.
- **Sustainability:** Grown using traditional farming methods, millets promote sustainability and environmental friendliness, contrasting with modern industrial farming practices.
- **Versatility in Culinary Use:** Millets can be incorporated into various culinary preparations, offering versatility in cooking and providing diverse options for meals.
- **Balances Blood Sugar Levels:** The complex carbohydrates in millets contribute to stable blood sugar levels, making them a favourable choice for individuals managing diabetes.
- **Weight Management:** The high fibre content in millets promotes a feeling of fullness, aiding in weight management and supporting overall digestive health.
- **Cardiovascular Health:** Millets contain nutrients that may contribute to cardiovascular health, including lowering cholesterol levels and promoting heart well-being.
- **Antioxidant Properties:** Some millets possess antioxidant properties, which can help neutralise free radicals and contribute to overall health and well-being.

Pulses

Pulses are a crucial component of Indian anti-oxidant, providing essential protein for human consumption and enriching soil fertility through nitrogen fixation. **India is the world's largest producer of pulses, contributing 24.2% of the global pulse production.** Pulses rank third in terms of cultivated area in India, following rice and wheat. Rabi pulses contribute more than 60 percent of the total production. Following are some of the key pulses grown in India:

1. **Chana (Bengal Gram/Desi Chickpea)**
   - **Subtropical Crop:** Primarily cultivated during the rabi season.
   - **Climate Requirements:** Moderate temperatures between **24°C and 30°C**.
   - **Cultivation Methods:** Can be grown under both irrigated and rainfed conditions.
   - **Seasonality:** Sown during the cool season, they are harvested as the as temperatures warm up.

- **Cultivation Area:** In the 2018-19 rabi season, cultivated over **95.59 lakh hectares**.
- **Major Production Regions:** Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Uttar Pradesh, and Andhra Pradesh.
- **Yield Statistics:** Despite around **40%** of the irrigated area being under chana cultivation, yields have marginally increased.

2. **Tur (Pigeon Peas)**
   - **Tropical Crop:** Predominantly cultivated in semi-arid regions.
   - **Climate Requirements:** Thrives in temperatures between **26°C and 30°C** during the rainy season and **17°C to 22°C** in the post-rainy season.
   - **Major Cultivation States:** Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Uttar Pradesh, Jharkhand, Telangana, Odisha, Tamil Nadu, and Andhra Pradesh.
   - **Contribution of Major States:** Maharashtra alone accounts for around **28%** of the total tur cultivation area.

Advantages of Pulses Cultivation

- Pulses are **leguminous crops** that can help restore soil fertility by fixing **nitrogen** from the air. Pulses have a symbiotic relationship with nitrogen-fixing bacteria that live in their roots. This relationship allows pulses to use the nitrogen in the soil
- **Soil Conservation:** Incorporating pulses in crop rotation acts as a natural soil conservation measure, reducing the risks of soil erosion and depletion. Pulses contribute to maintaining soil structure and fertility.
- **Drought Resistance:** Many pulses exhibit resilience to drought conditions, making them suitable for cultivation in regions with water scarcity. Their ability to thrive in challenging environments enhances agricultural sustainability.
- **Enhanced Biodiversity:** Pulses play a crucial role in increasing biodiversity as they have the unique ability to fix nitrogen into the soil. This nitrogen fixation not only benefits the pulses themselves but also enhances overall soil fertility that supports diverse plant life.
- **Carbon Sequestration:** Multiple cropping systems, including intercropping or rotating crops with pulses, have a higher potential for soil carbon sequestration compared to mono-cropping. This contributes to mitigating climate change by storing carbon in the soil.
- **Affordable Protein Source:** Particularly beneficial for smallholder farmers, pulses serve as an economical source of proteins, offering a cost-effective alternative to animal-sourced protein. This accessibility is vital for addressing protein needs in resource-constrained communities.

By recognizing these advantages, the integration of pulses into agricultural systems becomes a holistic approach supporting ecological resilience, food security, and sustainable livelihoods for farmers. With pulse imports projected to touch 3 million tonnes,India need to attain atmanirbharta in pulse production to meet nutritional needs of a large vegetarian population, increase farmer incomes and turn balance of trade in pulses in India's favour.

Oilseeds

Oilseeds are a vital component of Indian agriculture as they serve as the primary source of vegetable oil in the country. India grows nine main types of oilseeds, which account for more than 70% of the domestic demand for edible vegetable oil. oilseed imports reached 16.5 mt, costing nearly 1.38 lakh crore in 2023 and are further slated to rise on the back of rising income and population. It is major potential source of farmers income especially in rainfed areas as well as can save around 20 billion dollars in forex every year if we reach atmanirbharta in it.

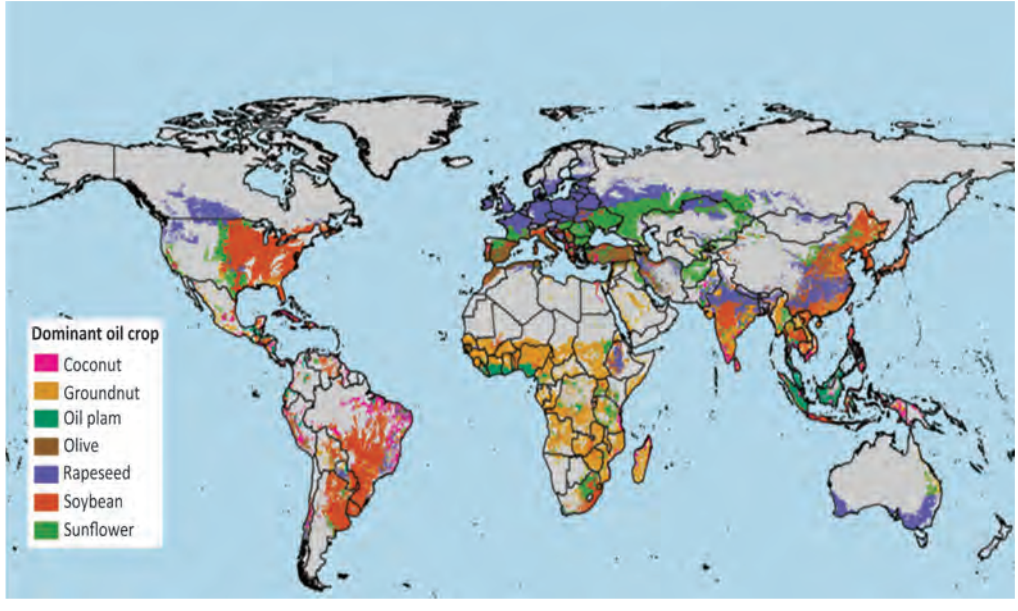


Fig. 8.13: Global Oilseed Distribution

Some key oilseeds grown in India are mentioned below:

1. **Groundnut (Peanuts)**
   - **Climate Requirements:** Thrives in tropical and subtropical climates, requires temperatures between **20°C and 25°C**, sensitive to frost.
   - **Rainfall:** Requires adequate rainfall ranging from **50 to 100 cm**, crucial for optimal growth and yield.
   - **Global Production Share (2019):** India is the world's second-largest producer, contributing **10.13%**.
   - **Cultivation Season:** Grown as a rain-fed kharif crop in dry lands, and in some regions as a rabi crop.
   - **Major Producing States:** Gujarat, Rajasthan, Andhra Pradesh, Tamil Nadu, Karnataka, Telangana, Madhya Pradesh, Maharashtra, and West Bengal.
   - **Cultivation Area:** Occupies around **5%** of the total cultivated area in India.

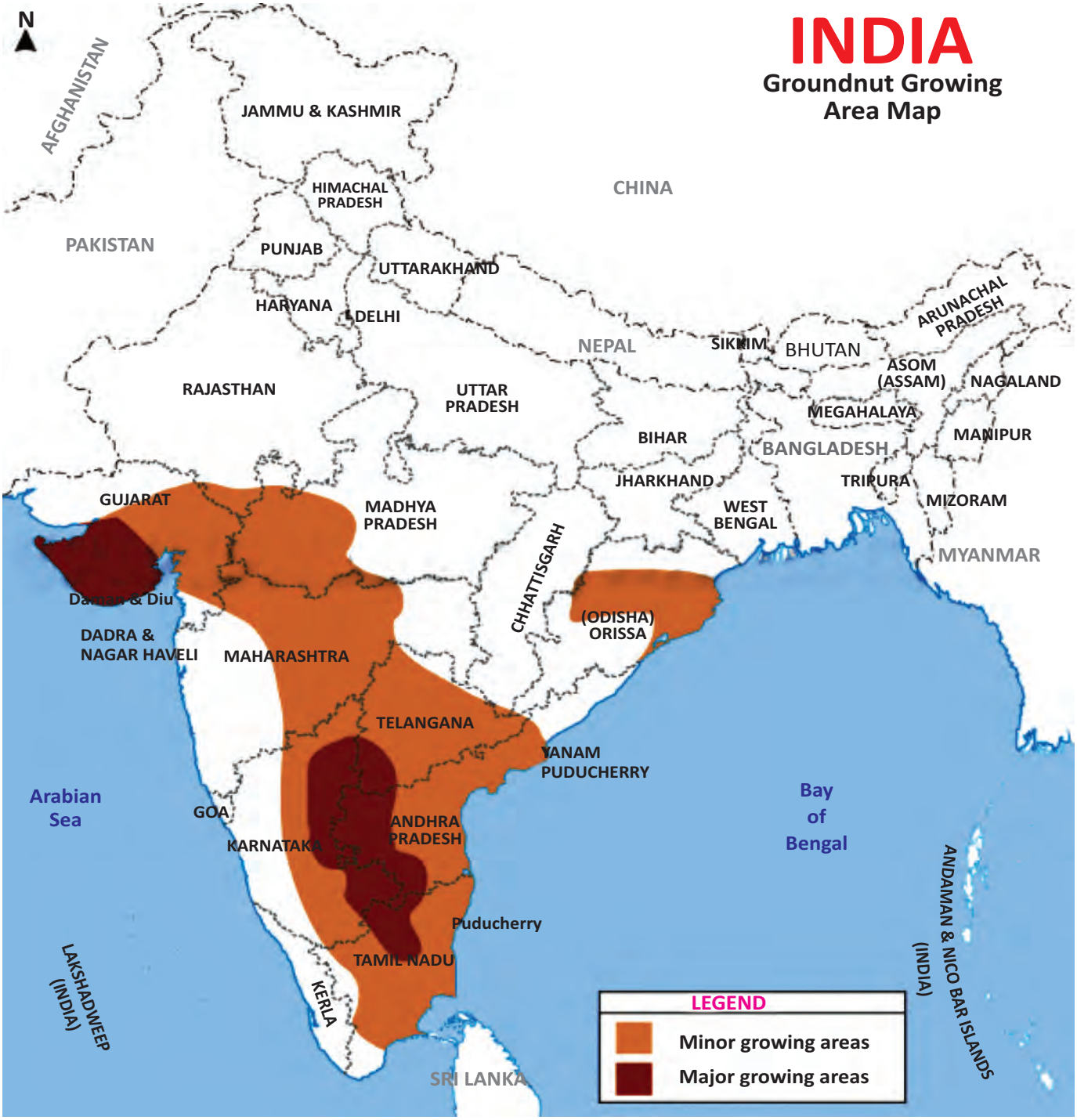


Fig. 8.14: Major Groundnut Growing Area Map in India

2. Rapeseed and Mustard

- **Climate Requirements:** Sub-tropical crops grown during the rabi season, require temperatures between **10°C and 25°C**.
- **Rainfall:** Thrives in regions with annual rainfall ranging from **625 to 1000 mm**.
- **Global Production Ranking:** India ranks third globally in rapeseed production, contributing **11%**.
- **Area and Production Growth:** Increase in both area and production due to expanded irrigation and improved seeds.
- **Major Producing States:** Rajasthan, Haryana, Madhya Pradesh, Uttar Pradesh, West Bengal, Gujarat, Jharkhand, Assam, Bihar, and Punjab.

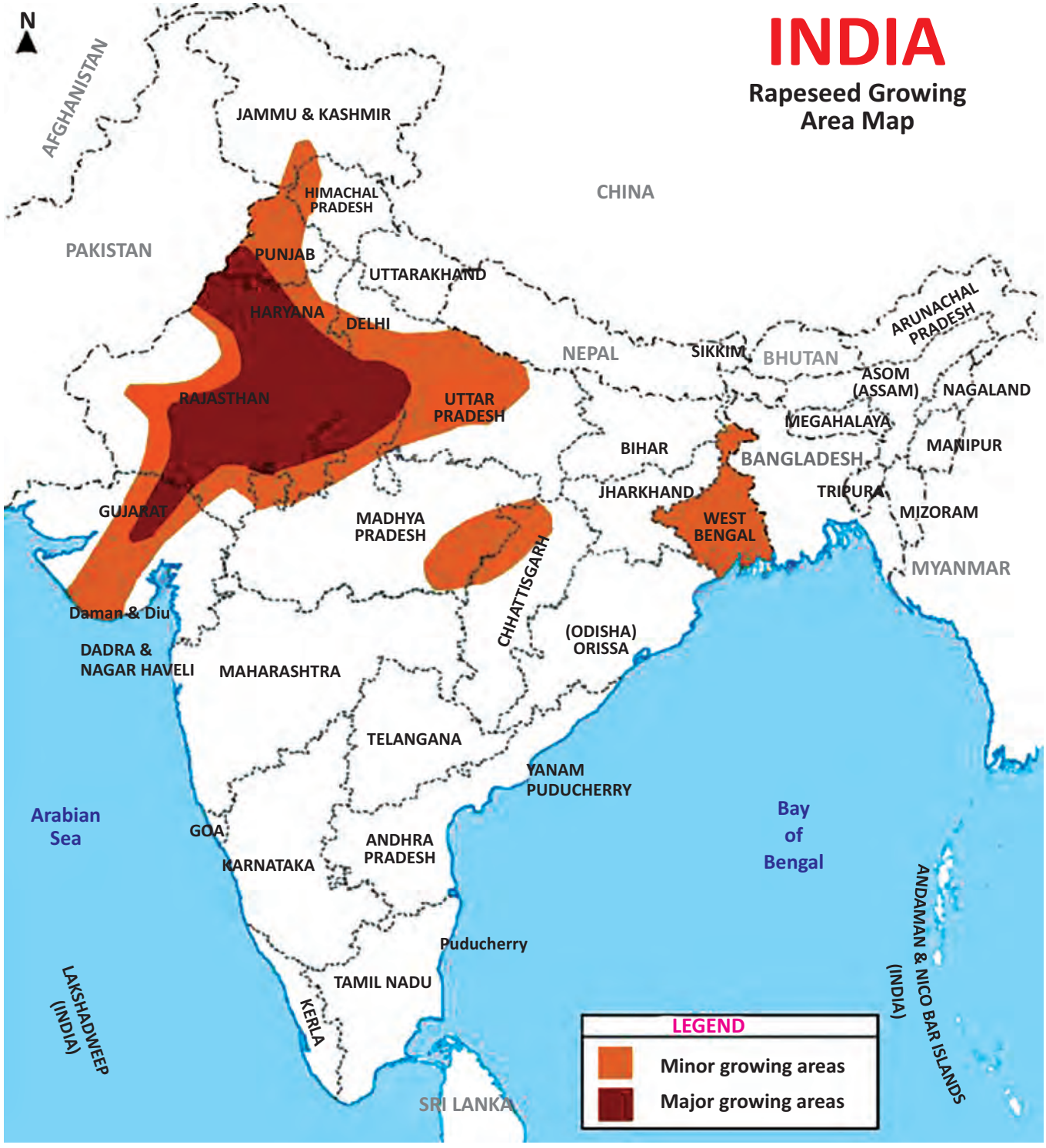


Fig. 8.15: Major Rapeseed Growing Area Map in India

3. Soybean

- **Cultivation Area:** It covers approximately **10.33 million hectares** in India.
- **Temperature Range:** Flourishes in warm and moist climates, ideal temperature between **26°C and 30°C**.
- **Major Producing States:** Madhya Pradesh and Maharashtra, with significant contributions from Rajasthan.
- **Yield Growth:** Improved yields contributing to the growth of soybean production in India.

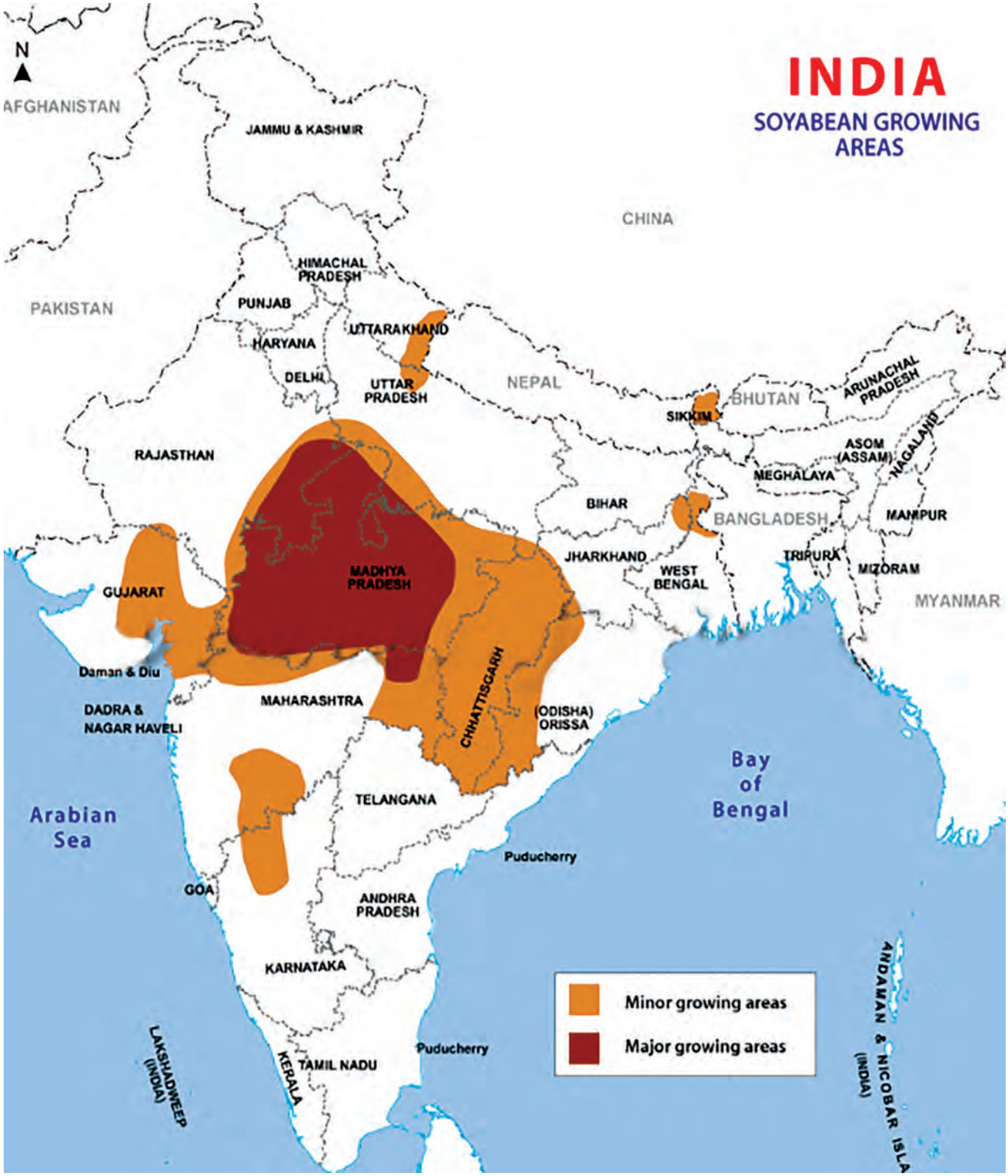


Fig. 8.16: Major Soyabean Growing Area Map in India

4. **Sunflower**
   - **Cultivation Area:** Grown on approximately **0.25 million hectares** of land in India.
   - **Frost-Free Period:** Requires a frost-free period of approximately **120 days** for successful commercial cultivation.
   - **Temperature Range:** Thrives within a temperature range of **20°C to 25°C**, with an optimum range slightly higher, **27°C to 28°C**.
   - **Major Producing State:** Karnataka, with smaller cultivation in Odisha, Haryana, Bihar, and Andhra Pradesh.
5. **Sesame (Til)**
   - **Temperature Requirements:** Optimal growth temperatures between **25°C and 35°C**; temperatures exceeding **40°C** can reduce oil content.
   - **Global Production Ranking:** India ranks first globally in sesame production.
   - **Cultivation Area and Yield: 19.47 lakh hectares** and **8.66 lakh tonnes annually**; average yield of **413 kg/ha**.
   - **Cultivation Challenges:** Rainfed cultivation on marginal lands with limited resources.
6. **Linseed**
   - **Climate Requirements:** Cool-season rabi crop suited for temperate climates, temperatures ranging from **10°C to 38°C**.
   - **Rainfall/Irrigation:** Adequate rainfall or irrigation is essential; well-drained, fertile soils ideal for cultivation.
   - **Plant Characteristics:** Annual herbaceous plant growing to **30-120 cm** in height with a fibrous root system.
   - **Major Producing States:** Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Jharkhand, Bihar, Maharashtra, Karnataka, Odisha, West Bengal, and Assam.

Palm Oil

Palm oil, extracted from the reddish pulp of oil palms, is a versatile ingredient used in cooking, cosmetics, processed foods, and biofuel.

- **Indonesia and Malaysia** dominate global production, accounting for nearly **90%**. While criticised for unsustainable practices and labour issues, its affordability and high yield make it popular.
- **India, the largest importer**, sources 40% of its vegetable oil from palm oil, meeting half its annual need from Indonesia.
- In 2021, India launched the National Mission on Edible Oil-Oil Palm to enhance domestic production

The quantity of imported edible oils is more than the domestic production of edible oils in the last five years.

Fibre Crops

Fibre crops are significant in India's agricultural landscape and contribute to the **textile industry**. Two of the most important fibre crops in India are cotton and jute, with mesta being another lesser-known fibre crop. Here's some information about these crops:

Cotton

- **Global Ranking:** India is the world's **second-largest producer** of cotton, contributing **24.43%** of global production.

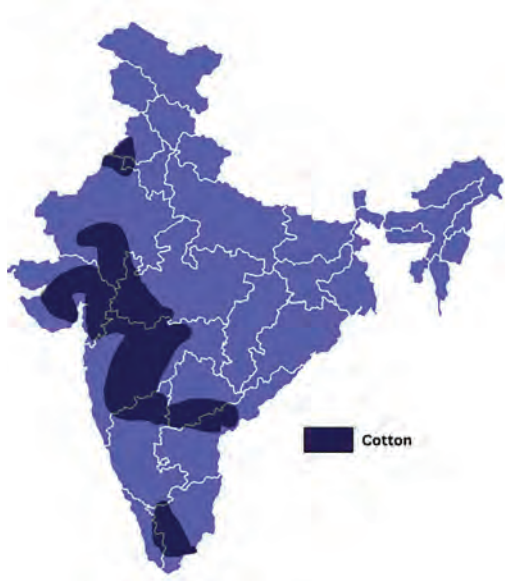


Fig. 8.17: Cotton producing region in India

- **Climate Requirements:** Requires a warm, frost-free climate with temperatures between **21°C to 30°C**.
- **Rainfall:** Moderate rainfall ranging between **50-75 cm** is necessary for optimal growth.
- **Soil Conditions:** Thrives in well-drained, loamy soils with a slightly acidic to neutral pH. Black soil, rich in nutrients like calcium carbonate, magnesium, potash, and lime, is ideal for cotton cultivation.
- **Pollination Requirements:** Proper humidity and wind conditions are essential for pollination.
- **Cultivation Trends:** Significant increase in cotton cultivation from **1960 to 2018**, with rising area under cultivation, yield levels, and production.
- **Expansion Under Irrigation:** Cotton cultivation under irrigation has also expanded over the years.
- **Major Producing States:** Maharashtra, Gujarat, Telangana, Andhra Pradesh, Rajasthan, Karnataka, Haryana, Madhya Pradesh, and Punjab.
- **Top Producing State:** Gujarat leads in cotton production, contributing around **one-third** of the total production in India.
- Black soil, also known as regur or black cotton soil, is characterised by its richness in nutrients like calcium carbonate, magnesium, potash, and lime, making it ideal for cotton cultivation.

Bt Cotton

Bt cotton is a **genetically modified (GM) crop** that incorporates a gene from the soil bacterium Bacillus thuringiensis (Bt), which expresses an insecticidal protein. Various subspecies of B. thuringiensis found in soils are known for their toxicity to certain insect genera while being harmless to other organisms. Bt has been utilized globally, including in India, as an insecticide for controlling stored grain pests and as sprays in cotton Integrated Pest Management (IPM) programs. India approved its first biotech crop technology, **Bollgard Bt cotton** (using single-gene technology), for commercialization in 2002.

Features of Bt Cotton

- **Reduced Pesticide Use:** Bt cotton reduces pesticide usage, leading to decreased risks of poisoning for farmers and animals, as well as lower production costs.
- **Increased Yield:** Bt cotton enhances yields by effectively controlling pests, benefiting farmers in India and other developing countries.
- **Improved Integrated Pest Management (IPM):** Bt cotton facilitates the adoption of improved IPM strategies, combining natural controls with targeted chemistry to further reduce pesticide use.
- **Soil Health:** Studies show that Bt cotton has no adverse effects on soil invertebrates, ensuring soil health and sustainability.
- **Environmental Protection:** Bt cotton varieties effectively control insect pests while reducing reliance on insecticides, promoting eco-friendly farming practices without compromising yield.
- **Biosafety and Non-Target Organism Toxicity Assessment**: Biosafety tests demonstrate the safety of Bt cotton to animals like goats, cows, buffaloes, fish, and poultry. Feed-safety studies indicate no adverse effects on animals fed with Bt cotton seed meal.

Bollgard II technology, featuring a double-gene approach with Cry1Ac and Cry2Ab, offers enhanced protection against bollworms and Spodoptera caterpillars.

Cotton Corporation of India (CCI)

Established on July 31, 1970, under the **Ministry of Textiles**, Government of India, the CCI operates as a Public Sector Undertaking in accordance with the Companies Act 1956.

- Its primary role is to conduct price support operations, without any quantitative limit, when the market prices of kapas fall below the minimum support prices (MSP) set by the Government of India.
- Additionally, CCI undertakes commercial purchase operations to meet the raw material needs of the domestic textile industry, especially during the lean season.
- With over 400 cotton procurement centres across major cotton-growing states, CCI operations cover:
  - Punjab, Haryana, and Rajasthan in the Northern Zone;
  - Gujarat, Maharashtra, Madhya Pradesh, and Orissa in the Central Zone; and
  - Andhra Pradesh, Telangana, Karnataka, and Tamil Nadu in the Southern Zone.

Jute and Mesta

Despite losing some jute-growing areas to Bangladesh, India remains the **world's leading producer of jute**, contributing 55.6% of total global jute production.

- **Temperature Range:** Jute can thrive within a broad temperature range of **20°C to 40°C,** with optimal growth occurring at temperatures between **30°C to 34°C.**
- **Rainfall Adaptability:** Flourishes in regions with high rainfall, even up to **500mm** during its growth period, making it adaptable to various climatic conditions.
- **Cultivation Trends:** Despite losing some jute-growing areas to Bangladesh, the area under jute and mesta has decreased slightly, but total production has nearly doubled due to improved yields.
- **Primary Cultivation States:** Jute cultivation is primarily concentrated in the eastern states of **West Bengal, Bihar, and Assam.**
- **Significant Contribution:** These states collectively account for a significant portion of both jute cultivation area and production in India.

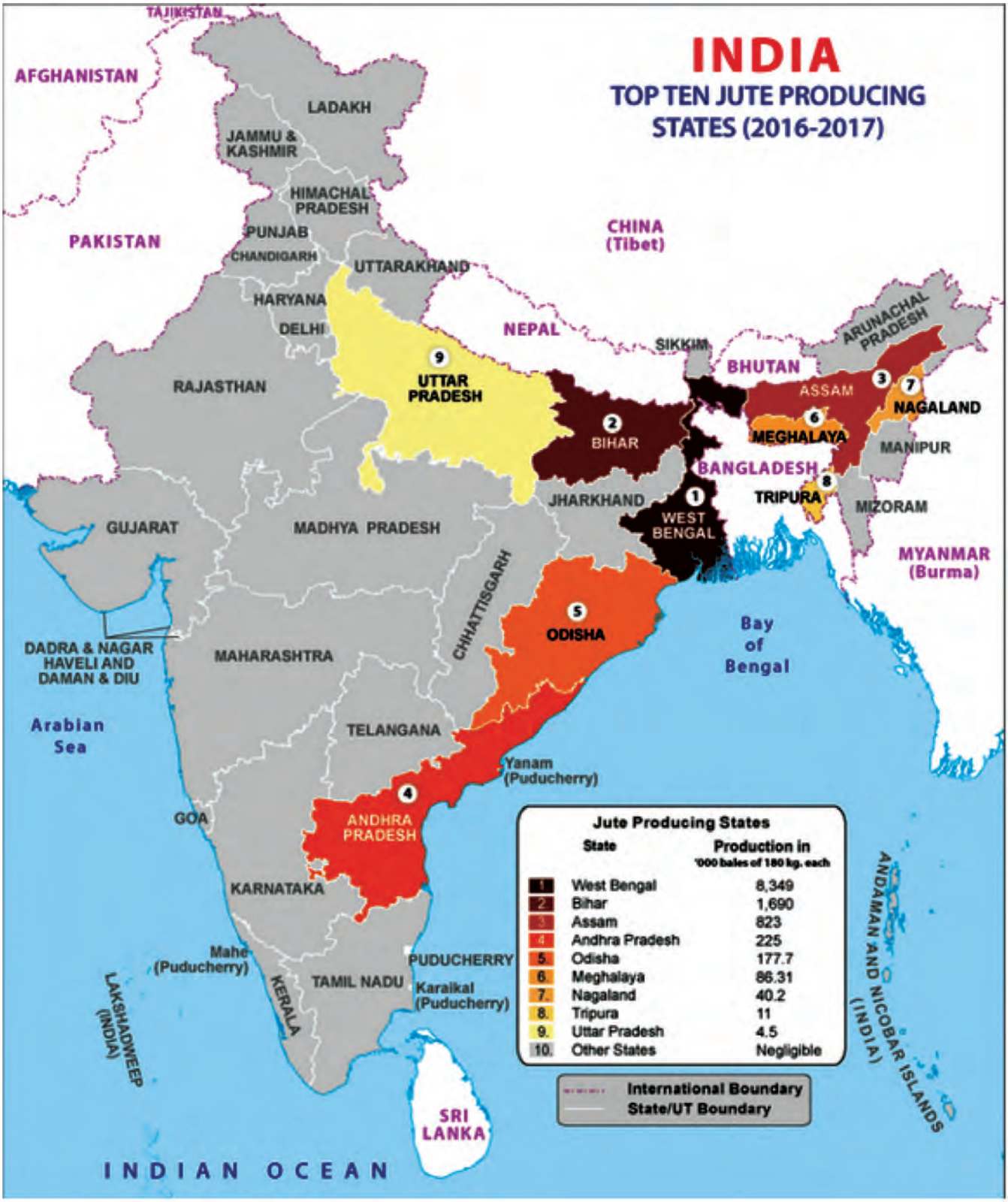


Fig. 8.18: Major Jute Growing Area Map in India

Plantation Crops

Plantation crops are large-scale agricultural undertakings managed by individuals or corporations. Notable plantation crops in India include tea, coffee, rubber, cocoa, coconut, arecanut, oil palm, and cashew. These high-value commercial crops hold substantial economic importance, contributing significantly to India's economy through exports, job generation, and poverty reduction, particularly in rural areas. Some of the plantation crops are explained below:

Fig. 8.19: Major Sugar Growing Area Map in India

Sugarcane

Sugarcane is a tropical crop grown in sub-humid and humid conditions. India is the **second-largest producer** of sugarcane in the world, after Brazil.

- Sugarcane cultivation demands **specific conditions:** a temperature range of 21°C to 27°C, annual rainfall between 75 to 100 cm (with irrigation in drier regions), and adaptable soil, preferably deep, rich, loamy and moisture-retentive.
- Soil fertility is crucial, requiring sufficient nitrogen, phosphorus, and calcium for successful growth and sugar production. In 2017, India contributed 16.6% of the world's total sugarcane production, while Brazil accounted for 41.2%.
- Sugarcane cultivation in India has seen substantial growth in terms of area, production, and yield since 1960-61. This progress can be attributed to improved cultivation practices and increased irrigation.
- **Major sugarcane-producing states** in India include Uttar Pradesh (46.6%), Maharashtra (21.8%), Karnataka (8.2%), Tamil Nadu (4.52%), Bihar (3.64%), Gujarat (3.18%), Haryana (2.54%), Punjab (2.11%), Andhra Pradesh (2.04%), Uttarakhand (1.85%), Madhya Pradesh (1.43%), Telangana (0.89%).

- Interestingly, yield levels of sugarcane vary significantly across states, with some states achieving much higher yields than the national average. For example, Tamil Nadu, Maharashtra, Haryana, Karnataka, and Punjab have notably high sugarcane yields.

Shifting of sugar industry from North to South India

The sugar industry in India is gradually shifting from North India to Peninsular India due to several factors like:

- Peninsular India's **tropical climate** results in **higher yields** per hectare and higher **sucrose** content in sugarcane.
- Additionally, the longer crushing season in the south, lasting nearly 8 months compared to 4 months in the north, provides a competitive advantage.
- Moreover, mills in Peninsular India tend to be larger and more efficiently managed, particularly those in Maharashtra, despite Uttar Pradesh having more sugar mills.
- Cooperative sector mills in the south also contribute to the region's prominence in sugar production.

These factors collectively contribute to the industry's transition to Peninsular India.

- Instead of MSP, **Sugarcane has Fair and Remunerative Price**, which is decided by the **Cabinet Committee on Economic Affairs(CCEA)**, where as **MSP** is decided by **Commission for Agriculture Pricing and Costs(CAPC).**
- It is known to be a water guzzler along with Rice and Wheat.

Tea

India is the **world's second-largest tea producer,** following China. India contributes approximately 28% of the world's total tea production.

- Tea plants flourish in cool to warm climates with a minimum of 5 hours of daily sunlight. Ideal annual temperatures range from 15°C to 23°C, while a cumulative annual temperature of 3,500 to 4,000°C is necessary for their robust growth and successful tea production.
- Tea cultivation primarily takes place in hilly areas with suitable topography and climatic conditions, including Assam, West Bengal, Arunachal Pradesh, Meghalaya, Nagaland, Himachal Pradesh, Sikkim, Tripura, Uttarakhand, Bihar, Karnataka, Kerala, and Tamil Nadu. Assam is the leading state in both tea cultivation areas (53.2%) and production (51%) in India.
- Together, Assam, West Bengal, and Tamil Nadu account for about 93% of India's tea production. Darjeeling Tea, often referred to as the "Champagne of teas" globally due to its floral aroma, was the pioneering product that received a GI tag. Additionally, both Green and White tea variants from Darjeeling also boast GI tags.
- British planters attempted to establish tea gardens along the Shivaliks and lesser Himalayas from Assam to Himachal Pradesh, but they couldn't replicate the success of Darjeeling. Factors such as geography, soil, labour force, and marketing strategies in Darjeeling all contributed significantly to the success of tea cultivation.

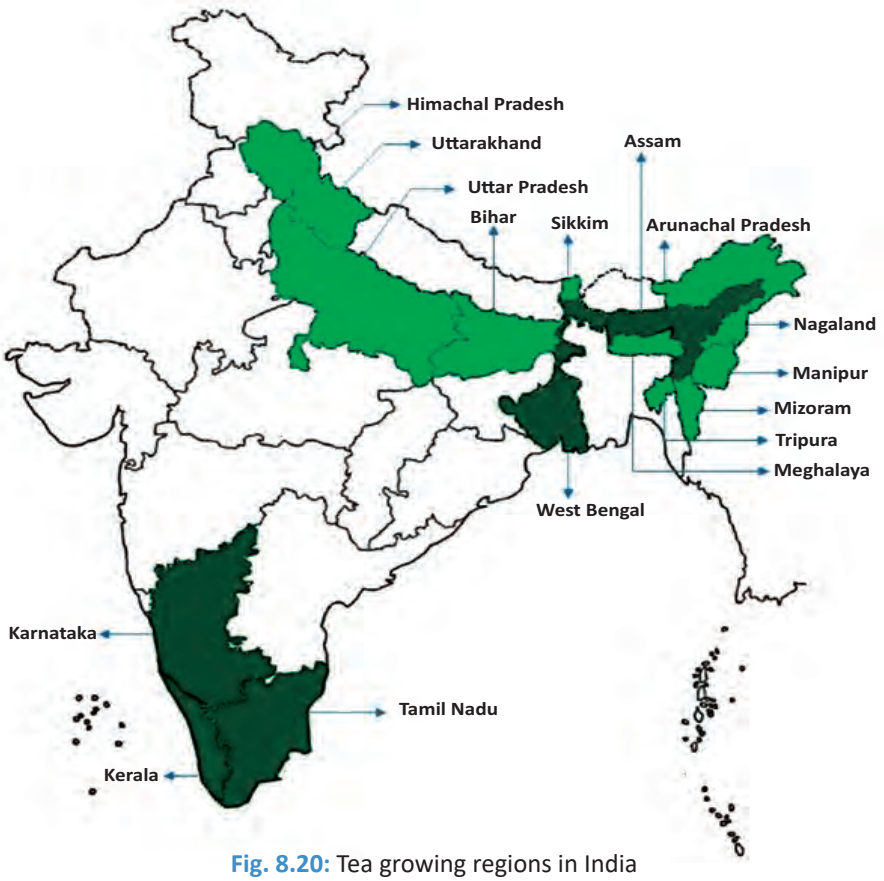


Fig. 8.20: Tea growing regions in India

Tea Board of India

Established as per Section (4) of the Tea Act, 1953 under the Ministry of **Commerce**, this statutory body was formed to foster the growth of India's tea industry. Operational since 1954, its aim is to position the nation as a premier global tea producer, achieved through various programs and initiatives. Headquartered in **Kolkata**, it operates 18 regional offices throughout India, along with two international branches in Dubai and Moscow.

Tea Board of India Initiatives:

- **Tea Development and Promotion Scheme:** Launched in November 2021 for the 2021-26 period, this scheme aims to boost productivity and quality in India's tea production. It comprises seven key components:
  - Plantation development for small tea farmers
  - Formulating sector-specific action plans for North East India
  - Supporting tea producers and traders in market promotion
  - Worker welfare initiatives
  - Research and development projects
  - Regulatory reforms
  - Establishment expenses
  - Additionally, it includes an Online Licensing System facilitating auto-renewal of three types of licences: exporter, tea waste, and tea warehouse licenses.
- **Chai Sahyog Mobile App:** This app caters to the needs of small tea growers, addressing various issues they encounter.

Coffee

Coffee is a plantation crop grown in tropical regions, and India primarily cultivates two varieties: **Arabica and Robusta**.

- India ranks eighth in the world in terms of coffee production, contributing 3.2% of the global total. Coffee cultivation prospers in cool to warm tropical climates with rich soils and minimal pest or disease presence.
- It thrives in a hot and humid environment, with temperatures spanning 15°C to 28°C, and requires annual rainfall ranging from 150 to 250 cm. These conditions ensure the growth of high-quality coffee beans.
- The traditional coffee cultivation areas in India are the highlands of the Western Ghats, spanning the states of Karnataka, Kerala, and Tamil Nadu. **Karnataka** leads in coffee production, accounting for approximately **55%** of the country's **coffee area**.
- These three traditional coffee-growing states collectively contribute 83.5% of the total coffee area in India.
- Non-traditional coffee cultivation areas include Andhra Pradesh, Odisha, and parts of the northeast. Coffee production in India mainly involves Arabica and Robusta varieties, and over **70% of India's coffee produce** comes from Karnataka.

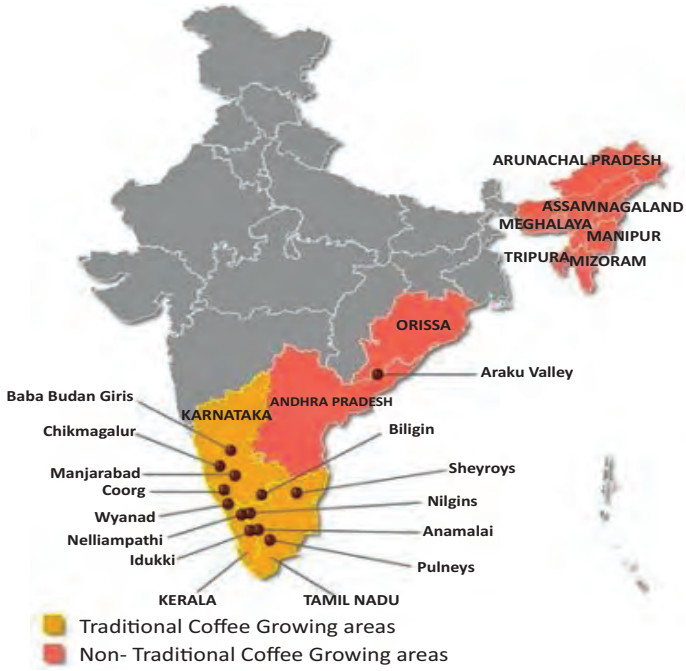


Fig. 8.21: Coffee Producing Areas of India

Coffee Board of India

The Coffee Board of India, established under Section (4) of the Coffee Act, 1942, operates under the supervision of the **Ministry of Commerce and Industry**, Government of India. Based in **Bangalore**, it consists of 33 Members, including the Chairperson, who serves as the Chief Executive. The Board primarily concentrates on research, extension services, development initiatives, market analysis, and both external and internal promotion of coffee.

Rubber

Rubber trees, vital for natural rubber production, flourish in tropical climates. They demand a year-round high temperature range of 20°C to 35°C, with a monthly mean of around 27°C, and suffer from temperatures below 20°C.

- These trees thrive in moisture-rich and humid environments, requiring annual rainfall exceeding 200 cm for robust growth and latex production. The Indian Rubber Industry holds a significant global position, ranking as the **world's third-largest** producer of natural rubber and the fourth-largest consumer.

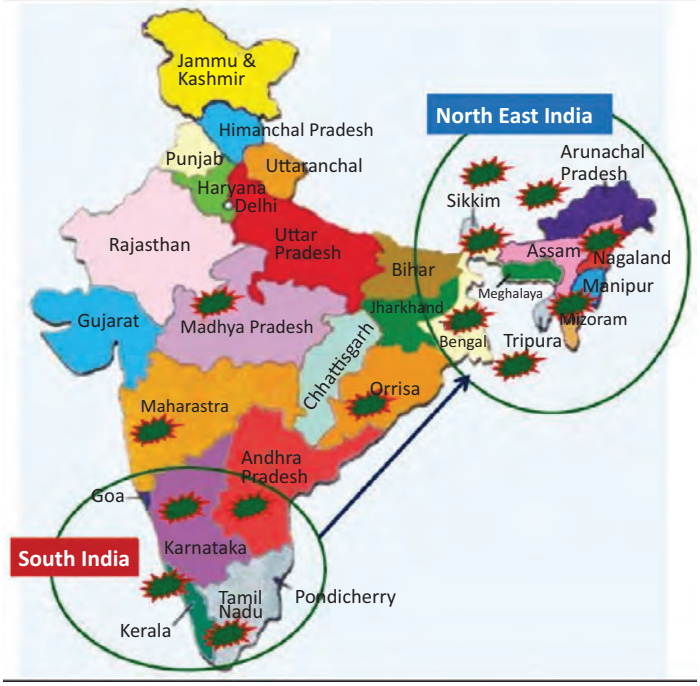


Fig. 8.22: Major Rubber Producing regions in India

- It also stands fifth globally in combined consumption of natural and synthetic rubber. Comprising around 6,000 units, including 30 large-scale, 300 medium-scale, and roughly 5,600 small-scale/tiny sector units, this industry manufactures an extensive array of 35,000 rubber products and provides employment to nearly 400,000 individuals, including about 22,000 technically qualified support personnel.
- With an impressive turnover of Rs. 200 billion, it contributes Rs. 40 billion to the National Exchequer through taxes, duties, and other levies, playing a vital role in the Indian national economy.

- **Mango** growing states in India are Uttar Pradesh, Andhra Pradesh, Telangana, Bihar, Gujarat, Tamil nadu. Uttar Pradesh ranks first in Mango production.
- India is the largest producer and consumer of **Areca nuts**. It is also known as Betel nut. Grown in coastal areas of India.
- **Tobacco** cultivation was introduced by the Portuguese into India. Gujarat is the largest producer followed by Andhra Pradesh. **Guntur** in Andhra is an important tobacco producing region.
- About 75% of **Ground nuts and Soybean** and more than half of **Cotton** is grown in the Rain-fed region.
- **Orchids** can be broadly classified into three types. Epiphytic- Plants growing on other plants or on rocks; Terrestrial- Plants growing on land and climbers; Mycoheterotrophic- plants which derive nutrients from Mycorrhizal Fungi that are attached to the roots of a vascular plant.

Summary of Climatic Conditions of all Crops

Crop	Conditions for Growth
Rice	❑ Hot and humid climates, extended sunshine, and an abundant, reliable water supply. ❑ Temperature: 21 to 37°C throughout its life cycle, with a maximum tolerance of 40 to 42º C. ❑ Soil: Well-drained clayey or loamy soil, good water retention capacity. Acidic to slightly alkaline soil (pH 5.0-7.5).
Wheat	❑ Temperature: Between 10-15°C (Sowing time) and 21-26°C (Ripening & Harvesting) with bright sunlight. ❑ Rainfall: About 75-100 cm ❑ Soil: Well-drained fertile loamy and clayey loamy (Ganga-Satluj plains and black soil region of the Deccan).
Barley	❑ High levels of drought and sodic condition tolerance, but intolerant to frost and has moderate water requirements. ❑ Temperature: During the growth phase, it needs 12 to 15 degrees Celsius, and around 30 degrees Celsius at the mature stage. ❑ Soil: Adaptable, but prefers loamy soils with a slightly acidic to neutral pH (6.0-7.5).
Maize	❑ Temperature: Between 21-27°C with at least 8 hours of direct sunlight per day; requires about 140 frost-free days for its growth. ❑ Rainfall: High rainfall; Adequate and consistent moisture is crucial, especially during the critical stages of tasseling and silking. ❑ Soil Type: Old alluvial soil.

Cotton	❑ Temperature: Between 21-30°C; sun-loving crop and receives at least 6 to 8 hours of direct sunlight daily. ❑ Rainfall: Around 50-100 cm; Cotton requires clear sky during the flowering stage. ❑ Soil Type: Well-drained black cotton soil of Deccan Plateau.
Bajra (Pearl Millet)	❑ Rainfall: Needs only 40 to 60 millimetres of annual rainfall. ❑ Temperature required for bajra is around 20°C to 30°C for its growth. ❑ Drought and heat tolerant crop. Grows in a wide range of soils, but not advisable in water-logged and acidic soils
Jowar (sorghum)	❑ Rainfall: Requires moderate amounts of 30-100 cm. ❑ Temperatures: Ranging from 20 to 32°C are conducive for jowar. ❑ Adversely affected by both excessive moisture and prolonged drought. ❑ Well-drained light soils are considered ideal for its growth.
Ragi	❑ It requires a warm climate and is known to survive even in drought. ❑ Rainfall: Moderate of about 50-100 cm. ❑ Temperature: A minimum of 8-10°C for germination and about 26-29°C for growth ❑ Soil: Red, light black, sandy, well-drained alluvial loams.
Tur (Arhar)	❑ Prone to reduced radiation levels in the monsoon season and during cloudy weather. ❑ Rainfall: Moderate of about 60-100 cm. ❑ Temperature: Ranging from 20-30°C. ❑ Soil: Well-drained black cotton soils with a pH range of 7.0 to 8.5
Gram	❑ Temperature: Well-suited for both cool-season and warm-season climates. Ideal range is 15-25°C. Relatively cold-tolerant. ❑ Soil: Well-drained, sandy loam to loamy soils with a slightly acidic to neutral pH (6.0-7.5). ❑ Rainfall: Well-distributed rainfall during its growing season.
Moong	❑ Soil: Well-drained loamy soils with a slightly acidic to neutral pH (6.0-7.0). ❑ Temperature: Full sunlight for optimal growth, of about 6-8 hours daily. ❑ Adequate moisture during critical growth stages, such as flowering and pod development
Urad	❑ Temperature: Ranging between 25°C and 35°C ❑ Can tolerate periods of drought, but consistent moisture is crucial for optimal yields ❑ Soil: Well-drained loamy soil with pH of 6.5 to 7.8; Cannot be grown on saline and alkaline soils
Lentil	❑ Well-drained loamy soil with neutral reaction are best for lentil cultivation ❑ Temperature: ideal range is 18°C to 30°C ❑ Acidic soils are not fit for lentils.
Groundnut	❑ Temperature: Average temperature of 30°C-35°C with abundant sunlight ❑ Rainfall: 40-125 cm of well distributed rainfall. ❑ High altitudes, cold and frost are not suitable ❑ Soil: A well-drained, light, loose, friable, sandy loam soil.
Rapeseed-Mustard	❑ Temperature: 10°C-25°C ❑ Rainfall: 625-1000 mm ❑ Thrives in a dry, chilly climate ❑ Soil: Alluvial loam is the best soil. Black cotton soil is not recommended for mustard cultivation.
Sunflower	❑ When sunflower plant is in the bud to flowering stage, it tends to follow the movement of the sun daily from east to west ❑ Temperature: 18-25°C; Needs cool climate during germination and seedling growth, warm weather from seedling stage up to flowering and non-cloudy sunny days during flowering to maturity. ❑ Soil: Loose, well-drained, somewhat alkaline soil with a pH of 6.0 to 7.5
Soyabean	❑ Temperature: 20-30°C; Warm-moist climates are required ❑ Soil: Well-drained, but not sandy, soils having a pH of 6.5 or above ❑ Rainfall: 500 to 600 mm of well-distributed rainfall

Sesame	❑ Temperature: 20-30°C; Oil content reduces above 40°C. ❑ Soil: well drained light to medium textured soil. ❑ Evenly distributed rainfall but is very sensitive to excessive water.
Sugarcane	❑ Temperature: Between 21-27°C with hot and humid climate. ❑ Rainfall: Around 75-100 cm. It is a water guzzler. ❑ Soil Type: Well-drained, deep, and fertile soils. Deep rich loamy soil. ❑ Adequate moisture is essential, especially during critical growth stages such as germination, tillering, and early growth.
Raw Jute	❑ Temperature: Between 25-35°C. Thrives in warm and humid climates. ❑ Rainfall: Around 150-250 cm. Adequate moisture during the growing season is crucial, especially during the initial stages of growth. ❑ Soil Type: Well drained alluvial soil (Ganga-Brahmaputra Delta). The soil should be loamy and rich in organic matter.
Copra(Coco	❑ Temperature: Ideal temperature is between 27-32°C. Thrives in warm and humid climates. ❑ Rainfall: Around 150-250 cm. ❑ Soils: Can tolerate a range of soil types, including sandy, lateritic, and saline soils.

AGRO-CLIMATIC ZONES OF INDIA

- In 1988, India's Planning Commission introduced a strategic approach to long-term resource efficiency and sustainability by delineating **15 Agro-Climatic Zones (ACRs).** These ACRs aimed to optimise agricultural planning based on similar natural resource endowments.
- Each zone was further subdivided into **73 sub-zones** considering factors like soil type, climate, and topography. Planning teams were established for each ACR, emphasising intrinsic factors related to the agricultural economy.
- While other socio-economic elements were considered for data collection, the primary focus remained on agricultural development. The recent resurgence in ACR usage aims to tailor research and development strategies for.

Agro-climatic zones of India
Agro-Climatic Zone
1. Western Himalayan
2. Eastern Himalayan
3. Lower GangeticPlains
4. Middle Gangetic Plains
5. Upper Gangetic Plains
6. Trans Gangetic Plains
7. Eastern Plateau & Hills
8. Central Plateau & Hills
9. Western Plateau & Hills
10. Southern Plateau & Hills
11. East Coast Plains & Hills
12. West Coast Plains & Hills:
13. Gujarat Plains & Hills
14. Western Dry Region
15. Islands

Fig. 8.23: Agro-climatic Zones of India

- Agriculture's productivity, income, employment, and resource allocation challenges while reducing regional disparities. Information for each zone is discussed in the table below.

Zone	Region	Location	Climate	Main Crops
1	Western Himalayan Region	Jammu and Kashmir, Himachal Pradesh, parts of Uttarakhand	Mild summers, harsh winters, ample rainfall (150 CM) Temperature(5°C-30°C, 0°C to -4°C)	Rice, maize, wheat, horticultural crops
2	Eastern Himalayan Region	Sikkim, Darjeeling (West Bengal), Arunachal Pradesh, Assam hills, Nagaland, Meghalaya, Manipur, Mizoram, Tripura	Rugged topography, sub-humid climate (25°C-33°C-July, 11°C-24°C-January) Rainfall>200cm	Rice, potato, maize, tea, various fruits
3	Lower Gangetic Plains Region	Eastern Bihar, West Bengal, Assam Valley	Annual rainfall 100-200 cm, waterlogging and marshy lands (26°C-41°C-July, 9°C-24°C-January)	Rice, banana, mango, citrus fruits, pisciculture
4	Middle Gangetic Plains Region	Eastern Uttar Pradesh, Bihar (excluding Chotanagpur plateau)	Fertile alluvial plains, annual rainfall 100-200 cm (26°C-41°C-July, 9°C-24°C in January)	Rice, maize, wheat, gram, barley, peas, mustard, potato

5	Upper Gangetic Plains Region	Central and western parts of Uttar Pradesh	Sub-humid continental climate, sandy loam soil (26°C-41°C in July, 7°C-23°C in January) Rainfall is75-150 cm	Wheat, rice, sugarcane, millet, maize, gram
6	Trans-Gangetic Plains Region	Punjab, Haryana, Delhi, Chandigarh, Ganganagar districts in Rajasthan	Semi-arid climate, private tube wells, canals (26°C-42°C in July, 7°C-22°C in Jan) Rainfall-70-125 cm	Wheat, cotton, rice, sugarcane, maize, gram
7	Eastern Plateau and Hills Region	Chotanagpur Plateau, Rajmahal Hills, Chhattisgarh Plains, Dandakaranya	Climate 26°C-34°C in July, 10°C-27°C in January Rainfall-80-150 cm	Rainfed agriculture, red and yellow soils
8	Central Plateau and Hills Region	Bundelkhand, Baghelkhand, Bhander Plateau, Malwa Plateau, Vindhyachal Hills	Semi-arid to sub-humid climate, 50-100 cm rainfall (26°C-40°C in July, 7°C-24°C in Jan)	Millet, gram, barley, wheat, cotton, sunflower
9	Western Plateau and Hills Region	Punjab, Haryana, Delhi, Chandigarh, Ganganagar districts in Rajasthan	Arid soils, arid climate, 25-75 cm rainfall (24°C-41°C in July, 6°C-23°C in Jan)	Jowar, cotton, sugarcane, rice, bajra, wheat, gram
10	Southern Plateau and Hills Region	Southern Maharashtra, Karnataka, western Andhra Pradesh, northern Tamil Nadu	Semi-arid climate, 50-100 cm rainfall (26°C-42°C in July, 13°C-21°C in Jan)	Jowar, bajra, ragi, groundnut, sesamum, sunflower
11	East Coast Plains and Hills Region	Coromandel and Northern Circar coasts	Sub-humid maritime climate, 75-150 cm rainfall (26°C-32°C in July, 20°C-29°C in Jan)	Rice, groundnut
12	West Coast Plains and Ghats Region	Malabar and Konkan coasts, Sahyadri mountains	Humid climate, rainfall (>200 cm, 19°C-28°C in Jan, 26-32°C in July)	Rice, sugarcane, coconut, oilseeds, pulses, cotton
13	Gujarat Plains and Hills Region	Kathiawar, fertile valleys of the Mahi and Sabarmati rivers	Arid to semi-arid climate, 50-100 cm rainfall (26°C-42°C in July, 13°C-29°C in Jan)	Oilseed production
14	Western Dry Region	Western Rajasthan west of the Aravallis	Arid region, <25 cm annual rainfall (Extreme temperature variations)	Limited vegetation, extreme temperature variations
15	Islands Region	Andaman-Nicobar, Lakshadweep	Equatorial climate, <300 cm annual rainfall (30°C (July), 25°C (January)	Rice, maize, millets, pulses, areca nut, coconut

CROP ROTATION

Crop rotation is a systematic approach to managing agricultural land. It involves planting different crops in a specific sequence or pattern in the same field over time. By rotating crops and avoiding planting the same species or family in the same location year after year, farmers can break the life cycles of pests and pathogens, utilise nutrients more efficiently, and improve overall soil quality.

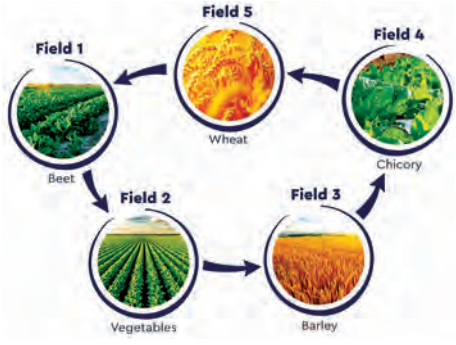


Fig. 8.24: Crop Rotation

Objectives of Crop Rotation

- **Diversifying Crops:** Crop rotation ensures that different types of crops are grown in the same field over time. Each crop has specific nutrient requirements and interacts differently with soil and pests.
- **Nutrient Management:** Different crops have varying nutrient needs. By rotating crops, it helps in preventing the depletion of specific nutrients in the soil. For example, leguminous crops, like beans and peas, can fix nitrogen from the atmosphere and enrich the soil.
- **Pest and Disease Control:** Crop rotation disrupts the life cycles of pests and diseases. Many pests and pathogens are specific to certain crops. Rotating crops reduces the buildup of these pests and diseases, making it less likely for them to become a problem.
- **Weed Suppression:** Different crops can have different root structures and growth habits. Rotating crops can help manage weeds by interrupting their growth cycles and preventing the dominance of specific weed species.

How Does Crop Rotation Work?

Let's say a farmer has a field, and in one growing season, they plant corn. Corn is a nutrient-demanding crop that depletes nitrogen from the soil. After the corn harvest, the farmer may choose to plant beans in the same field for the next season. Beans are leguminous crops that can fix nitrogen in the soil, replenishing what was depleted by corn. This rotation not only helps with nutrient management but also disrupts pest and disease cycles associated with corn. The following year, the farmer might opt for a different crop, such as wheat or oats, which have different nutrient requirements and interact with pests differently. This rotation continues over several years, ensuring that no crop is planted in the same field in consecutive growing seasons.

Advantages of Crop Rotation

- **Improves Soil Condition:** Crop rotation enhances soil quality by introducing different crops with varying nutrient requirements. This practice increases organic matter content, nutrient levels, and water-holding capacity in the soil.
- **Enhances Soil Structure:** Crop rotation helps maintain and improve soil structure. Different crops have different root structures and depths, which gradually enhance the topsoil's depth and quality.
- **Reduces Soil Erosion and Water Runoff:** By promoting healthier soil structure and microbial populations, crop rotation reduces erosion and minimises surface water runoff, contributing to soil conservation.
- **Reduces Pests and Weeds:** Pests and weeds that specialise in a particular crop struggle when their host crop is rotated, disrupts their life cycles and reduces their populations.
- **Control of Insects:** Insects often target specific host plants. Crop rotation can lead insects to encounter plants they don't feed on, reducing pest damage.
- **Disease Prevention:** Crop rotation can prevent the recurrence of plant diseases by disrupting the disease organisms' life cycles and reducing their buildup in the soil.
- **Improvement in Water Quality:** Reduced sediment loss and nutrient runoff due to improved soil quality can lead to better water quality in nearby water bodies.
- **Diversification:** Crop rotation allows farmers to diversify their crops, spreading out the workload and potentially increasing their product range and income.
- **Nutrient Uptake Regulation:** Different crops have varying nutrient requirements. Crop rotation optimises nutrient uptake from the soil, making the most of available nutrients.

Disadvantages of Crop Rotation

- **Financial Investment:** Crop rotation can require substantial upfront costs. Farmers need to purchase different crop seeds and possibly invest in various types of equipment, which can be expensive.
- **Skill and Knowledge:** Successful crop rotation demands a broader skill set and knowledge base because it involves managing various types of crops and equipment.
- **Difference in Growing Conditions:** Some regions and climates are better suited for specific crops. Crop rotation may not be feasible in areas where the growing conditions are highly specialised.
- **Obligatory Crop Diversification:** Effective crop rotation requires planting different crops each time, preventing specialisation in a particular crop.

Crop rotation has historically replaced fallow periods, allowing for continuous soil nutrient replenishment and increased productivity. It also offers environmental benefits by reducing soil erosion and pesticide use. However, its success depends on factors like soil type, climate, and market demands.

Agricultural Productivity & Intensification

Agricultural Productivity: Agricultural productivity is the ratio of agricultural outputs to inputs, often measured by the market value of final agricultural products. This metric evaluates the efficiency and effectiveness of agricultural processes, considering factors like labour, land, capital, and resources. It provides insights into the agricultural sector's contribution to the economy.

Agricultural Intensification: Agricultural intensification involves enhancing land productivity by increasing inputs, such as labour, resources, or technology, per unit of land area over time. This process aims to improve agricultural output and efficiency, ultimately increasing yields and productivity on existing farmland.

CROPPING INTENSITY

Cropping intensity refers to the practice of cultivating multiple crops from the same land within a single agricultural year. It is calculated by dividing the Gross Cropped Area (total area sown once, twice, or more during the year) by the Net Sown Area (total area planted with orchards and crops, counting areas sown multiple times only once) and multiplying by 100 **(i.e. Cropping Intensity = Gross Cropped Area/Net Sown Area x 100).**

Increasing cropping intensity can be achieved through several methods, including improving irrigation systems, using fertilisers to reduce fallow periods, implementing crop rotation, mechanising farming, adopting high-yield crop varieties, and employing cropping techniques like intercropping and relay cropping.

In India, cropping intensity varies due to factors like climate, soil and population density, with some regions having high intensity like Punjab and Haryana. Increasing cropping intensity offers benefits like higher yields and food diversity but can harm the environment and livestock, and lead to groundwater depletion. Sustainable water management is crucial to mitigate these challenges.

Crop Concentration
Crop concentration refers to the degree to which a particular crop is grown in a specific region at a given time. Several factors influence the concentration of crops in an area, including topography, climate, soil type, and the agricultural practices of local farmers.

VARIOUS REVOLUTIONS IN AGRICULTURE SECTOR

The term "agricultural revolution" in India signifies profound transformations in farming practices driven by innovation and technology adoption. These changes aim to increase agricultural productivity and enhance food security. India has witnessed various agricultural revolutions. These initiatives have played pivotal roles in ensuring self-sufficiency in food production, promoting sustainable agriculture, and fostering growth in agriculture sectors.

Important Agricultural Revolutions In India	
Revolution	**Description**
Green Revolution	The Green Revolution refers to a significant increase in food grain production, primarily wheat and rice, attributed to the introduction of **high-yielding variety (HYV)** seeds into developing countries. This revolution marked a departure from traditional farming practices and involved the widespread adoption of modern techniques and inputs, such as synthetic fertilisers and pesticides. **Dr M. S. Swaminathan,** the advisor to India's minister of agriculture, played a pivotal role in inviting **Norman Borlaug** to India to kickstart the Green Revolution. India's Green Revolution began in 1968 and was led by Prime Minister Indira Gandhi. It resulted in a substantial increase in food grain output, particularly benefiting regions like Punjab, Haryana, and Uttar Pradesh. During this period, the development of new synthetic insecticides, herbicides, and chemical fertilisers helped address India's pressing issue of food insecurity. The Green Revolution significantly contributed to India's food grain production, allowing the country to achieve self-sufficiency in food.
Evergreen Revolution	The Evergreen Revolution is a strategy aimed at improving **agricultural productivity** while prioritising sustainability and resource efficiency. It focuses on achieving higher yields using fewer resources, such as water and pesticides, to ensure the long-term sustainability of agriculture. The Evergreen Revolution emphasises the integration of modern information and communication technology (ICT) into Indian farming practices. As part of the Digital India initiative, the **e-Kranti** pillar is dedicated to providing technology solutions for farmers, including real-time pricing updates, online input ordering, and mobile banking for payments.
Yellow Revolution	The Yellow Revolution started in 1986-87 and aimed to increase the production of **edible oil,** particularly from oilseeds like mustard and sesame seeds. Sam Pitroda is recognized as the driving force behind the Yellow Revolution. The Yellow Revolution focused on nine key oilseeds, including groundnut, soybean, mustard, safflower, sunflower, sesame, niger, linseed, and castor. The introduction of hybrid mustard and sesame seeds, coupled with advanced technologies, significantly enhanced edible oil production. Between 1986 and 1991, the Yellow Revolution led to a substantial increase in edible oil production, reducing India's reliance on imports.
Blue Revolution	The Blue Revolution is a government program designed to promote the expansion of the **aquaculture sector,** primarily focusing on **fisheries**. The Fish Farmers Development Agency (FFDA) played a pivotal role in initiating the Blue Revolution during the 7th Five Year Plan (1985-1990). Over time, the program led to the establishment of fishing harbours in various coastal regions of India. The Department of Animal Husbandry, Dairy, and Fisheries, along with the Ministry of Agriculture and Farmers Welfare, aims to streamline and restructure various programmes related to fisheries and aquaculture under the banner of the "Blue Revolution." The Blue Revolution has contributed to the growth of the fisheries sector in India, resulting in increased fish production and improved livelihoods for fishermen.
Golden Fiber Revolution	The Golden Fiber Revolution started in the 1990s is closely associated with the **jute manufacturing industry** and aims to modernise and revitalise it. Jute is a natural fibre known for its golden sheen and cost-effectiveness, hence referred to as the "golden fibre." India was a significant contributor to jute manufacturing before independence, but the industry faced challenges post-independence, leading to the need for revitalization. The Golden Fiber Revolution seeks to restore the jute manufacturing industry's prominence and boost its economic contributions.
Golden Revolution	The Golden Revolution, spanning from 1991 to 2003, focused on **horticulture,** making India a global leader in fruit production. India became a major producer of various fruits, including cashew nuts, coconuts, and mangoes, during this period. The revolution had a positive impact on the economic conditions of many farmers engaged in horticulture, enhancing their standard of living. The establishment of greenhouses to protect crops from natural disasters was a noteworthy aspect of the Golden Revolution.

Grey Revolution	The Grey Revolution related to increased **fertiliser production** that emerged in the aftermath of the 1960s, prompted by the limitations of the Green Revolution. It aimed to improve upon the Green Revolution's shortcomings and develop sustainable solutions for the food system. India, having previously focused on seed productivity, turned its attention to fertiliser use as a means to stimulate growth during this revolution.
Pink Revolution	The Pink Revolution pertains to the modernization of the **poultry and meat processing industry** in India. The concept of the Pink Revolution was initially introduced in India in 1964 but gained significant momentum in the late 1990s. **Durgesh Patel** is recognized as the Father of the Pink Revolution. It encompasses advancements in the poultry and meat industry, onion production, and pharmaceuticals. India, with its large population of poultry and cattle, has significant growth potential in this industry. The Pink Revolution focuses on upgrading meat and poultry processing to meet international standards and cater to the domestic market.
Silver Revolution	The substantial surge in **egg production** is attributed to the "Silver Revolution," which received support from both public and private entities. This revolution occurred between 1969 and 1978 during the tenure of Prime Minister Indira Gandhi. **Dr BV Rao,** the founder of Venkys (a renowned Indian Poultry Company), served as a key inspiration for this transformation in the poultry industry. It spanned nine years and propelled **India to become the world's third-largest egg** producer, following China and the United States. The combined efforts of the Indian government, private enterprises like Venkys, scientists, and veterinarians played pivotal roles in elevating egg production in India. The Silver Revolution was marked by scientific advancements, including the creation of cock-hen hybrids, contributing to increased poultry productivity. It aimed to enhance egg production for the availability of safe and nutritious food.
Red Revolution	The "Red Revolution" in India, initiated in the 1980s and spanning until 2008, was a significant agricultural transformation focusing on **meat and tomato** production. **Vishal Tewari,** a key figure, led this revolution. Technological advancements and resource expansion contributed to 66% of this growth, with high-quality seeds further enhancing yields. The introduction of wholesale markets boosted farmers' profits. The remaining 34% growth resulted from factors like labour, capital, land, and raw materials. Although government measures supported the revolution, addressing ongoing challenges is crucial for sustaining tomato and meat production growth.
White Revolution	The White Revolution, also known as **Operation Flood,** aimed to boost **milk production** and transform India into one of the world's largest milk-producing nations. It established a national milk grid, reducing price disparities and ensuring farmers received a fair share of profits. **Dr. Verghese Kurien,** the chairman of the National Dairy Development Board, played a pivotal role and is often called the "Father of the White Revolution."
Silver Fiber Revolution	The "Silver Fiber Revolution," also known as the **Technology Mission on Cotton (TMC)**, led to a significant increase in **cotton production** in India. The name reflects the silvery appearance of cotton fibres. Similarly, the "Golden Fiber Revolution" is associated with jute production. Launched in February 2000, the TMC aimed to enhance cotton production and productivity while maintaining high-quality fibre internationally. The programme received funding from the Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, and was executed by the Indian Council of Agricultural Research through the National Agricultural Research System. It focused on various aspects of cotton research across nine crucial cotton-growing states in India. These states include Madhya Pradesh, Tamil Nadu, Punjab, Andhra Pradesh, Maharashtra, Haryana, Karnataka, Gujarat, and Rajasthan.
Protein Revolution	The Protein Revolution, initiated in 2014-2020, is a technology-driven green revolution aimed at increasing agricultural productivity, particularly in the production of protein-rich crops like lentils and pulses. It encourages farmers to employ scientific agricultural practices to boost yields, reduce imports of protein-rich crops, and enhance food security. The government is investing in the cultivation of lentils and pulses on a significant portion of agricultural land to achieve these goals.

ALLIED ACTIVITIES IN AGRICULTURE

Allied activities in agriculture refer to various complementary agricultural practices and sectors that support and enhance traditional farming activities. These activities play a crucial role in diversifying income sources for farmers, increasing farm productivity, and contributing to overall rural development. Some of the key allied activities in agriculture include.

- **Horticulture:** Horticulture involves the cultivation of fruits, vegetables, nuts, seeds, herbs, sprouts, mushrooms, algae, flowers, seaweeds, non-food crops such as grass and ornamental trees and plants.
  - Horticulture not only provides nutritious food but also generates significant income for farmers. Horticulture plays a substantial role in India's agricultural growth, constituting approximately 30.4 % of the agricultural Gross Domestic Product (GDP) while utilising only 13.1% of the gross cropped area.

- India's horticulture production surpasses that of food grains, with around 341.63 million tonnes (2021-22) of horticultural produce cultivated on a much smaller land area of 27.74 million hectares, in contrast to 127.6 million hectares used for food grain production. This highlights the significance of horticulture in the country's agricultural landscape.

- **Animal Husbandry:** Animal husbandry encompasses the raising of livestock such as cattle, goats, sheep, poultry, and fish farming.
  - It includes activities like dairy farming, poultry farming, and aquaculture. Livestock farming provides essential products like milk, meat, eggs, and wool, contributing to both food security and income generation.
- **Sericulture:** Sericulture involves the cultivation of silkworms to produce silk. It is an important source of income for many rural households and provides raw materials for the textile industry.
  - In the 2020-21 fiscal year, India ranked as the world's **second-largest producer** of silk. Among the four types of silk produced, Mulberry silk accounted for the majority at 70.72%, equivalent to 23,860 metric tonnes (MT).
  - **Tasar silk** contributed 8.02% (2,705 MT), Eri silk made up 20.55% (6,935 MT), and **Muga** silk constituted 0.71% (239 MT) of the total raw silk production, which amounted to 33,739 MT (Provisional).
  - However, the Covid-19 pandemic disrupted silk production in India during 2020-21. The total raw silk production for the year decreased by 5.8% compared to the previous year (2019-20). The country's export earnings from silk in 2020-21 reached Rs. 1418.97 crores.
  - In terms of employment, sericulture provided livelihoods for an estimated 8.7 million individuals in 2020-21, which was a 7.4% reduction from the 9.4 million persons employed in 2019-20.
- **Beekeeping:** Beekeeping or apiculture is the maintenance of bee colonies, usually in hives, to produce honey and other bee products like beeswax, royal jelly, and propolis.
  - It plays a crucial role in pollination and enhances crop yields. The Indian apiculture market was worth INR 16,818 Million in 2018. The market is further projected to reach INR 33,128 Million by 2024, growing at a CAGR of nearly 12% during 2019-2024.
- **Agroforestry:** Agroforestry combines agricultural and forestry practices by integrating trees and shrubs with crops or livestock. It promotes sustainable land use, and biodiversity conservation, and provides timber, fruits, nuts, and other non-timber forest products.
- **Fisheries:** Fisheries involve the cultivation of fish through aquaculture or the harvesting of fish from natural water bodies. It provides a vital source of protein and income for many communities.
  - India, ranking third in global fish production at 8%, significantly contributes to the country's GVA (1.1%) and agricultural GVA (6.72%). As the fourth-largest fish and fisheries product exporter, India witnessed a 26.73% growth in exports between FY 2021-22 and FY 2022-23.
  - This thriving sector provides livelihoods for over 28 million people and achieved a record-breaking export of 1.73 million metric tons worth $8.09 billion in FY 2022-23.
- **Poultry Farming:** Poultry farming includes the rearing of chickens, ducks, turkeys, and other birds for meat and egg production. It is a significant source of affordable protein and employment opportunities.
  - In 2018, the Indian poultry market, encompassing broilers and eggs, was valued at INR 1,750 billion. Projections indicate that this market is set to expand, reaching INR 4,340 billion by 2024, with a notable CAGR of 16.2% during 2019-2024.
  - India currently ranks among the world's top producers of eggs and broiler meat. The Indian poultry sector is estimated at approximately Rs. 80,000 crores for the year 2015-16, with a significant portion divided between the organised commercial sector, holding an 80% market share (around Rs. 64,000 crores), and the unorganised sector, constituting about 20% of the market share or Rs. 16,000 crores.
- **Dairy Farming:** Dairy farming is the management and care of dairy animals, primarily cows and buffaloes, for the production of milk and dairy products like cheese, butter, and yoghurt.
- **Agri-tourism** Agri-tourism involves opening up farms to visitors for educational and recreational purposes. It provides farmers with additional income and helps urban populations connect with rural life.
- The agritourism market in India is poised for substantial growth, with an anticipated compound annual growth rate (CAGR) of 19.9% from 2023 to 2028. Globally, the agri-tourism market reached a valuation of $42.46 billion in 2019, indicating its significant scale and potential for expansion.

CONCLUSION

From fertile fields to life-giving water, agriculture and irrigation are humanity's cornerstones. Climate change disrupts these systems, demanding sustainable practices like water conservation and innovative cultivation techniques. By fostering harmony with nature, we can ensure food security for a growing population in a changing world.

Industries in World & India

9

In the dynamic landscape of global economies, industries play a pivotal role in shaping the socio-economic fabric of nations. The term **'industry'** encompasses a wide array of sectors, each contributing uniquely to the overall development and progress of a country. This chapter delves into the intricate fabric of industries, examining their global and Indian landscapes. From the emergence of early industries during the Industrial Revolution to the sophisticated technological advancements of the 21st century, we embark on a journey to understand the multifaceted nature of industries and their impact on the world and India.

CLASSIFICATION OF INDUSTRIES

Criteria	Description
Based on Source of Raw Materials	❑ **Agro-based Industries:** These use raw materials obtained from agriculture, such as cotton, jute, sugar, tea, coffee, rubber, etc. ❑ **Mineral-based Industries:** These rely on minerals extracted through mining, including iron, steel, aluminium, cement, etc. ❑ **Forest-based Industries:** They utilize resources from forests, such as paper, resins, leaf utensils, baskets, etc. ❑ **Marine-based Industries:** They encompass shipping, fishing, energy, tourism, and technology, contributing to global trade, food production, and environmental conservation.
Based on Ownership	❑ **Private Sector Industries:** Owned and operated by private individuals or corporations. Examples include Bajaj Auto, Mahindra & Mahindra, and Tata Steel (TISCO). ❑ **Public Sector Industries:** Owned and operated by the government or state. Examples include BSNL (Bharat Sanchar Nigam Limited), Public Sector Undertakings (PSUs), and government-owned steel plants. ❑ **Cooperative Sector:** These industries refer to businesses collectively owned and operated by a group of individuals, typically producers of the raw materials specific to the industry. For example, a sugar mill owned and managed by farmers exemplifies this cooperative ownership model. ❑ **Multi National Ownership:** Multinational corporations typically establish offices and/or factories in various countries, maintaining a centralized head office for global management coordination. Such entities, alternatively referred to as international, stateless, or transnational corporate organizations, often boast budgets that surpass those of numerous small nations. Examples include TCS and Infosys. ❑ **Joint Ownership:** Joint ownership industries involve collabourative ownership structures where multiple entities share control and responsibilities, fostering shared interests and resources for mutual benefits. E.g., Hero Honda, Maruti Suzuki, etc.
Based on Strength of Labour & Size	❑ **Large-scale Industries:** These employ a significant number of workers, require substantial capital investment, and often use advanced technology. Examples include the cotton industry, the textile industry, and the automobile industry. ❑ **Medium Scale Industries:** These industries encompass those that have a moderate number of workers, falling between the extremes of very large and very small labour forces. Examples of such industries include the cycle industry, as well as the radio and television sectors. ❑ **Small-scale Industries:** These employ fewer workers, are typically run by individuals or small groups, involve lower investments, and produce a smaller volume of products. Examples include cottage industries, handicrafts, and power looms.

Based on Economic Activity	❑ **Primary Industries:** Involve the extraction or cultivation of natural resources directly from the environment, such as agriculture, mining, fishing, forestry, and farming. ❑ **Secondary Industries:** Engage in the transformation and processing of raw materials from primary industries into finished goods, including manufacturing, construction, and food processing. ❑ **Tertiary (Service) Industries:** Provide various services rather than physical products, such as retail, healthcare, education, hospitality, finance, and IT services. ❑ **Quaternary Industries:** It is concerned with information-based or knowledge-oriented products and services. Eg. Research and development, including technological development and scientific research; financial and strategic analysis and consulting. ❑ **Quinary Industries:** Quinary activities, conducted by top-tier policymakers or decision-makers, are commonly associated with "gold collar" professionals. This category encompasses individuals who engage in the generation, restructuring, and interpretation of novel and existing concepts, as well as the utilization and assessment of emerging technologies. Examples include senior business executives, government officials, research scientists, and financial or legal consultants.
Based on Technology and Innovation	❑ **Sunrise Industries:** Emerging sectors with high growth potential and innovation, often driven by new technologies. Examples include renewable energy, biotechnology, and artificial intelligence. ❑ **Sunset Industries:** Declining sectors facing obsolescence or reduced demand due to changing technologies or consumer preferences. Examples include traditional print media and some heavy manufacturing industries.
Based on Global Integration	❑ **Export-Oriented Industries:** Focused on producing goods and services primarily for export markets, contributing significantly to international trade. Example: Automotive, Electronics industry etc. ❑ **Domestic Market-Oriented Industries:** Primarily cater to the domestic market, serving the needs and demands of the local population. Example: Retail, Construction, Real estate, etc.
Based on Raw Materials	❑ **Heavy Industries:** These industries use bulky raw materials and produce bulky raw materials. E.g. Iron steel Industry. ❑ **Light Industries:** The finished products are light in weight. E.g. electric fans, sewing machines etc. ❑ **Agro based Industries:** Industries that derive their raw materials from agriculture are classified as agro-based industries. Examples of such industries include cotton textiles, jute textiles, sugar, and vegetable oils. ❑ **Forest Based Industries:** Industries relying on forest resources include those involved in the production of paper, cardboard, lac, rayon, resin, tanning leather, as well as the crafting of leaf utensils and baskets.
Based on Mode Of Operations	❑ Basic or key industries are those which supply their products as raw materials to manufacture other goods e.g. iron and steel and copper smelting, aluminum smelting. ❑ Consumer industries that produce goods for direct use by consumers – sugar, toothpaste, paper, sewing machines, fans. ❑ **Cottage Industries:** Small industries which are set up by artisans in their houses or villages. For example, handloom, khadi, woodwork, etc. ❑ **Ancillary Industries:** The industries that manufacture parts and components to be used by big industries are called ancillary industries. ❑ **Capital-Intensive Industries:** The industries which require huge investment are called capital-intensive industries. E.g. Iron and steel industry. ❑ **Labour Intensive Industries:** They require a huge labour force to run them. E.g. Shoe making industry.

FACTORS INFLUENCING THE LOCATION OF INDUSTRIES

The location of industries plays a significant role in how well they do. To lower the cost of transportation and manufacturing for a simple & quicker supply of meals to customers, it is cost-effective to establish industries close to the sources. There are several variables that affect where the industry is located, and they may be categorised into two main groups:

Geographical Factors

- **Raw Materials:** The availability of raw materials significantly impacts industrial locations in India. For instance, the sugar industry is concentrated in states like Uttar Pradesh and Maharashtra due to the abundance of sugarcane cultivation, ensuring a stable supply of raw materials.
- **Markets:** Proximity to markets is a key determinant. Urban centres like Mumbai and Ahmedabad are hubs for the cotton textile industry due to their proximity to consumer markets, which facilitates efficient distribution and reducing transportation costs.
- **Power:** India's aluminium industry, being power-intensive, often positions itself near power sources. Hydroelectric power plants in regions like Himachal Pradesh and Uttarakhand provide ample electricity supply, which is crucial for aluminium smelting operations.
- **Labour:** India's diverse labour force influences industrial locations. For example, Firozabad excels in glasswork, Yamunanagar in utensil manufacturing, Varanasi in silk weaving, and Mirzapur in carpet production.
- **Transport:** India's transportation infrastructure, including roads, rail, and ports, influences industrial locations. Ghaziabad's strategic location near Delhi with well-developed road and rail networks has attracted industries like synthetic fibre and electronics.
- **Water:** Access to water resources is crucial for industries. Kolkata benefits from the Hooghly River, which supports manufacturing processes. Mumbai and Chennai leverage coastal locations for seawater use in industries like petrochemicals and power generation.
- **Climate:** Climatic conditions also affect locations decisions. Coastal regions in Maharashtra and Gujarat offer favourable humid climates for industries like cotton textiles. Conversely, electronics manufacturing industries may require climate-controlled environments to manage humidity.

IGNITE YOUR MIND

Resource Curse or Blessing?: Explore the complex relationship between resource abundance (minerals, fertile land) and industrial development in specific regions. Can this relationship be optimized for sustainable growth?

Non-Geographical Factors

- **Capital:** Modern industries need significant capital. Major cities like Mumbai, Kolkata, Delhi, and Chennai thrive due to access to wealthy capitalists.
- **Government Policies:** Government policies shape industry location. They aim to reduce disparities, control pollution, and disperse industries. India's Five-Year Plans influence industrial emergence and regional advantages. **Example:** Location of oil refinery at Mathura, coach factory at Kapurthala, etc.
- **Industrial Inertia:** Industries often stay in their original locations despite changing circumstances, driven by history, established labour, and supply chains. **Example: Aligarh's lock industry.**
- **Efficient Management:** Effective management is crucial for industry success, preventing financial mismanagement, labour issues, and shutdowns.
- **Access to Banking:** Robust banking facilities are essential for managing industry finances efficiently. Areas with strong banking services are more favourable for industrial development.
- **Insurance:** Industries need insurance to protect against risks like machinery damage and worker injuries, ensuring business continuity.

Footloose Industries

Footloose industries can be located in a wide variety of places. They are not dependent on any specific raw material, weight loss, or otherwise. They produce in small quantities and also employ a small labour force. These are generally non-polluting industries. The important factor in their location is accessibility by road network. Eg. Watch making, Diamond cutting

Important Characteristics of Footloose Industries:

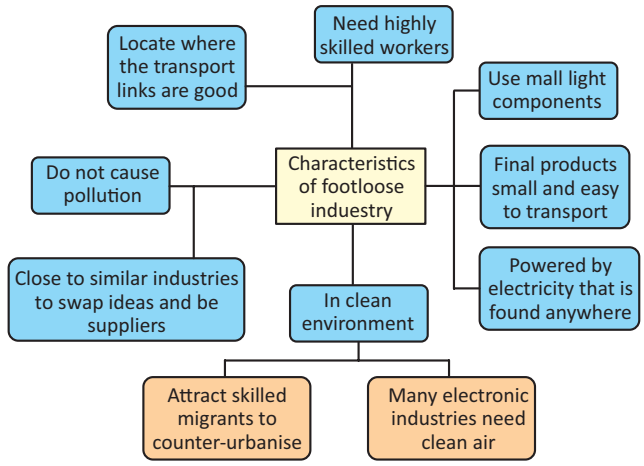

Need highly skilled workers
Locate where the transport links are good
Use mall light components
Do not cause pollution
Characteristics of footloose industry
Final products small and easy to transport
Close to similar industries to swap ideas and be suppliers
In clean environment
Powered by electricity that is found anywhere
Attract skilled migrants to counter-urbanise
Many electronic industries need clean air

Fig.9.1: Footloose industries

Locational Factors of Footloose Industries:

- **Transportation Infrastructure:** The state of Gujarat in India has seen the development of the Mundra Port, which is the largest commercial port in the country. The presence of such a well-connected seaport attracts industries to set up in the region.

- **Communication Infrastructure:** Bengaluru, often referred to as the Silicon Valley of India, is known for its robust IT industry. The city's advanced communication infrastructure, along with a skilled workforce, has attracted numerous technology companies.
- **Skilled Labour Force:** Pune, located in the state of Maharashtra, is known for its automotive and information technology industries. The presence of reputed educational institutions and a skilled labour force has contributed to its appeal for footloose industries.
- **Government Policies:** The Indian government's **"Make in India"** initiative, aimed at promoting manufacturing in the country, has attracted various industries. The implementation of business-friendly policies and incentives encourages companies to set up operations in India.
- **Energy Availability and Cost:** States like Tamil Nadu, with a focus on renewable energy, have become attractive for industries seeking reliable and cost-effective energy sources. The presence of wind farms and solar energy projects contributes to the appeal of such regions.
- **Political Stability:** Karnataka, particularly Bengaluru, has been known for its political stability. The state's favorable economic climate has contributed to its status as a hub for technology and startup industries.
- **Market Access:** Mumbai, as the financial capital of India, provides easy access to a large consumer market. The city's strategic location makes it attractive for industries seeking proximity to major business and financial centers.
- **Environmental Regulations:** Certain states in India, such as Himachal Pradesh, offer tax incentives and a favorable regulatory environment for industries. This has led to the establishment of pharmaceutical and electronic manufacturing units in the region.
- **Technological Infrastructure:** Hyderabad has emerged as a major hub for the information technology and pharmaceutical industries. The presence of research institutions and technology parks has made it an attractive location for footloose industries.
- **Flexibility in Location:** Special Economic Zones (SEZs) in various states, such as Gujarat and Maharashtra, provide a flexible environment for industries to operate in. These zones offer benefits such as tax exemptions and simplified regulations.
- **Cost of Living:** Tier 2 cities like Pune and Hyderabad, with a lower cost of living compared to metros like Mumbai or Delhi, attract industries looking to minimize operational costs while maintaining access to skilled talent.
- **Global Supply Chain Considerations:** Chennai, with its well-developed infrastructure and connectivity, serves as a strategic location for industries involved in global supply chains, especially automotive manufacturing and exports.

IGNITE YOUR MIND

Beyond Footloose: While technology makes some industries location-independent, what social and environmental factors might still influence their placement? Could these lead to new classifications beyond "footloose"?

Categorisation of Industries based on Pollution Index

The Government has released a new categorization of industries based on their pollution load.

- The **Ministry of Environment, Forest and Climate Change (MoEFCC)** has developed criteria for categorization of industrial sectors based on the Pollution Index, which is a function of **emissions (air pollutants), effluents (water pollutants), hazardous wastes generated and consumption of resources.**
- The **Pollution Index PI** of any industrial sector is a number from 0 to 100 and the increasing value of PI denotes the increasing degree of pollution load from the industrial sector.
- Following criteria on the **'Range of Pollution Index** 'for the purpose of categorization of industrial sectors is finalized.
  - Industrial Sectors with a Pollution Index score of 60 and above – **Red category**
  - Industrial Sectors with a Pollution Index score of 41 to 59 – **Orange category**
  - Industrial Sectors with a Pollution Index score of 21 to 40 – **Green category**
  - Industrial Sectors with a Pollution Index score incl.& upto 20 – **White category**

Categorisation of Industries Based on Raw material

Numerous industries are built around the extraction, processing, and utilization of raw materials. These industries play a crucial role in the global economy and cover a wide range of sectors. Here are some key industries based on raw materials:

MAJOR AGROBASED INDUSTRIES IN INDIA

Cotton Industry: World

Fig. 9.2: Agro-based Industries of India

Cotton is a natural fibre that is widely used for making clothing and textiles. It is grown in more than 75 countries, providing income and employment for millions of people. Cotton is also a major commodity in global trade, with China, India, and the United States being the top producers and consumers.

- **Ancient Origins:** Cotton has a rich history dating back to ancient civilizations, with evidence of cultivation found in India around 2500 BCE. Egyptians, Chinese, Persians, and Greeks also used cotton.
- **Spread and Popularity:** Cotton spread to Europe through trade routes, becoming popular during the Renaissance. The Industrial Revolution boosted demand and production, with inventions like the cotton gin, spinning jenny, and power loom making processing faster and cheaper.

Fig. 9.3: Distribution of cotton industries in the world

- **Textile Industry Development:** Cotton played a key role in the development of the textile industry, driving economic growth and social change.
- **Challenges in Modern Times:** The 20th and 21st centuries saw challenges such as the emergence of synthetic fibers, environmental and social impacts of production, and increased competition due to globalization and trade liberalization.

Geographical distribution of Cotton industry in the world

State	Key Points
China	❑ The textile industry was previously centered in Shanghai and Tientsin. ❑ Improvements in production have led to the establishment of new centres in the cotton-growing belt in Honan, Hopei, Shansi, and Shensi. ❑ Additionally, individual factories catering to local demands have been set up at Lan Chow, Urumchi, Kashgar, Chengtu, Taiyuan, Chengchow, Hong Chow, Nanking, Kaiteng, Tientsin, etc. ❑ Cloth manufacturing is now taking place in Taiyuan, and looms are under construction in Chengchow.
Russia	❑ Despite not being prioritized in its development plans, the textile industry in Russia has made significant contributions. ❑ Prior to the Revolution in 1917, the cotton textile industry was concentrated in Moscow and the Ivanovo region. However, it has since expanded to include other regions.
USA	❑ **New England:** Until a few years ago, New England held the title of the largest centre, but it has now been surpassed by the South. ❑ **Mid Atlantic:** Cotton factories in the Middle Atlantic States are situated in Pennsylvania, New York, and Maryland.

Cotton Industry: India

The cotton textiles industry is the largest organized modern industry in India, and it has experienced remarkable growth over the past four decades. It plays a significant role in the Indian economy, employing around 16% of the country's industrial capital and over 20% of its industrial labour force. The industry provides livelihoods for well over 15 million people. **India is the largest producer of cotton globally (2022-23).**

Three-quarters are spinning mills, while the remaining one-fourth are composite mills that handle various textile processes.In addition to these mills, there are tens of thousands of small factories with 5 to 10 looms, contributing to the diversity and vibrancy of the Indian textile sector. This data underscores the substantial size and significance of the cotton textiles industry in India's industrial landscape.

Evolution

- **Historical Background:** India's cotton textile history dates back to 1500 BC, when it held a global monopoly. First cotton mill in Kolkata (1818), Bombay Spinning and Weaving Company (1854), Shahpur mill in Ahmedabad (1861).
- **Impact of the Industrial Revolution and British Rule**: Discriminatory policies led to the decline of the Indian cotton industry and exports.

- **Partition in 1947** led to the loss of long-staple cotton-growing regions to Pakistan, impacting the industry.
- **Present Scenario:** Despite setbacks, the majority of cotton mills remain in India, with spinning centralized in Maharashtra, Gujarat, and Tamil Nadu.

Factors Affecting the Cotton Industry

- **Historical Development:** The cotton textile industry in India has a long history dating back to ancient times. Traditional handloom weaving and spinning were prevalent in various regions, leading to the emergence of **decentralised clusters** of textile production. This **historical legacy has shaped the industry's decentralized nature.**
- **Raw Materials:** Cotton in India serves as an unadulterated natural substance, with the proportion of raw cotton to the finished product, such as cotton yarn and fabric, remaining consistent. The weight loss of raw cotton (excluding cotton seeds) during processing is minimal. For example, in regions like **Gujarat and Maharashtra**, cotton forms the backbone of the textile industry.
- **Market:** The demand for apparel in India is intricately linked to evolving fashion trends. Notably, the Indian textile industry produces a wide array of manufactured textile products that cater to diverse consumer preferences. Over time, consumer tastes in India have shifted from traditional to more contemporary styles.
- **Climate:** India's mild and moist climate in regions like **Tamil Nadu and West Bengal** has been conducive to the historical development of the cotton textile industry. Many textile mills were traditionally established in areas with such favorable climatic conditions.
- **Labour:** India's cotton textile industry is renowned for being labour-intensive, with skilled and cost-effective labour playing a crucial role. States like **Uttar Pradesh and Karnataka** have a significant workforce engaged in various tasks, from spinning to weaving, contributing to the industry's success.
- **Power Resources:** Historically, textile industries in India were strategically located near water sources for power. For example, the textile mills in **Mumbai, Maharashtra**, were situated near the Arabian Sea for water-based power resources in the initial stages of development.
- **Capital:** In India, establishing a cotton factory, whether on a small or large scale, requires a considerable amount of capital. Textile hubs like Tirupur in **Tamil Nadu,** known for its knitwear industry, showcase how significant investments in fixed and mobile assets contribute to the success and scale of operations in the cotton textile sector.
- **Regional Specialization:** Different regions in India have specialized in specific aspects of the textile production process, such as spinning, weaving, and dyeing. For example, areas like Gujarat are known for their expertise in weaving, while Tamil Nadu is known for spinning. This regional specialization has contributed to the industry's decentralized structure.
- **Cottage and Small-Scale Industries:** A significant portion of the Indian textile industry consists of small-scale and cottage industries. These decentralized units often operate on a family or community basis, contributing to the dispersion of textile manufacturing across the country.
- **Government Policies:** Historically, government policies in India have also played a role in promoting decentralized industrialization, including the textile sector. Policies such as supporting small and cottage industries, providing subsidies, and promoting regional development have contributed to the decentralization of the cotton textile industry.

Geographical Distribution of Cotton Industry in India

State	Key Points
Maharashtra	❑ Maharashtra is second leading cotton producer. ❑ Employs around three lakh people. ❑ Mumbai, known as India's Cottonopolis, hosts 63 out of Maharashtra's 122 mills.
Gujarat	❑ Gujarat is the second-largest cotton textile producer. ❑ Ahmedabad, the second-largest centre for the industry, has 73 out of 118 mills.
Madhya Pradesh	❑ Abundance of cheap labour due to the backward economy. Important cotton-producing cities include Gwalior, Ujjain, Indore, Dewas, Ratlam, Jabalpur, and Bhopal.
Tamil Nadu	❑ A major cotton textile producer in southern India. ❑ Leads in yarn production (over 44% of the country's total). ❑ Coimbatore, known as the Manchester of South India, houses 200 of Tamil Nadu's 439 mills.
West Bengal	❑ Kolkata is crucial with a port, humid climate, coal supply, and dyeing facilities.
Uttar Pradesh	❑ The western part of the state is a hub for cotton textiles. Kanpur is the largest city known as Uttar Pradesh's Manchester. ❑ Ten of the state's 52 cotton textile mills are in Kanpur. Other important cities include Moradabad, Varanasi, Agra, Bareilly, Aligarh, and more.

Punjab	❑ Emerging as the leading cotton producer in the country. Research on new cotton varieties like BT cotton is centered in Amritsar and Ludhiana.
Other States	❑ **Andhra Pradesh:** Hyderabad, Secunderabad, East Godavari, Udayagiri. ❑ **Kerala:** Thiruvananthapuram, Alleppey, Kollam. ❑ **Bihar:** Gaya, Patna, Bhagalpur. ❑ **Rajasthan:** Kishangarh, Ganganagar, Bhilwara, Udaipur, Jaipur, Kota, Ajmer. ❑ **Haryana:** Bhiwani, Hisar, Rohtak. ❑ **Karnataka:** Bangalore, Mangalore, Gulbarga, Channapatna, Mysore.

Current Status of Cotton Industry in India

- ❑ According to Wisevoter, India is the **World's largest producer ranked 1.** Cotton Production by Country 2023 - Wisevoter of cotton, producing 5,900,000 tons in 2023.
- ❑ About **two-thirds** of India's cotton production originates from Maharashtra, Gujarat, Andhra Pradesh, and Telangana, collectively recognized as the Cotton Basket of India.
- ❑ Gujarat is the **largest producer of cotton in India**, accounting for around 27% of the country's total cotton production.
- ❑ Rainfed areas account for roughly 62% of India's cotton production, while irrigated lands contribute to the remaining 38%.
- ❑ India cultivates all **four known species namely Gossypium arboreum, Gossypium herbaceum, Gossypium hirsutum, and Gossypium barbadense**.
- ❑ The cotton industry in India is predominantly geared towards apparel exports, making up around 51% of the total apparel exports. Notably, approximately 74% of India's exported apparel is cotton-based.
- ❑ India's cotton is freely exportable, with key destinations including the US, Bangladesh, China, Vietnam, Pakistan, Indonesia, Taiwan, and Thailand.
- ❑ **Bangladesh** has emerged as the primary importer of Indian cotton since FY 2015, with expectations of a more than 43% increase in cotton exports from India due to robust demand, especially from China.

Significance of Cotton Industry

India, holding the First position globally. Cotton Production by Country 2023 - Wisevoter, boasts the largest area dedicated to cotton cultivation. This positions the country as a leader in low-cost cotton sourcing, offering a competitive advantage over other nations.

- ❑ **Average Wage Rate:** In India, the average wage rate is 50-60% lower than that in developed countries. This cost advantage positions India favorably in the global

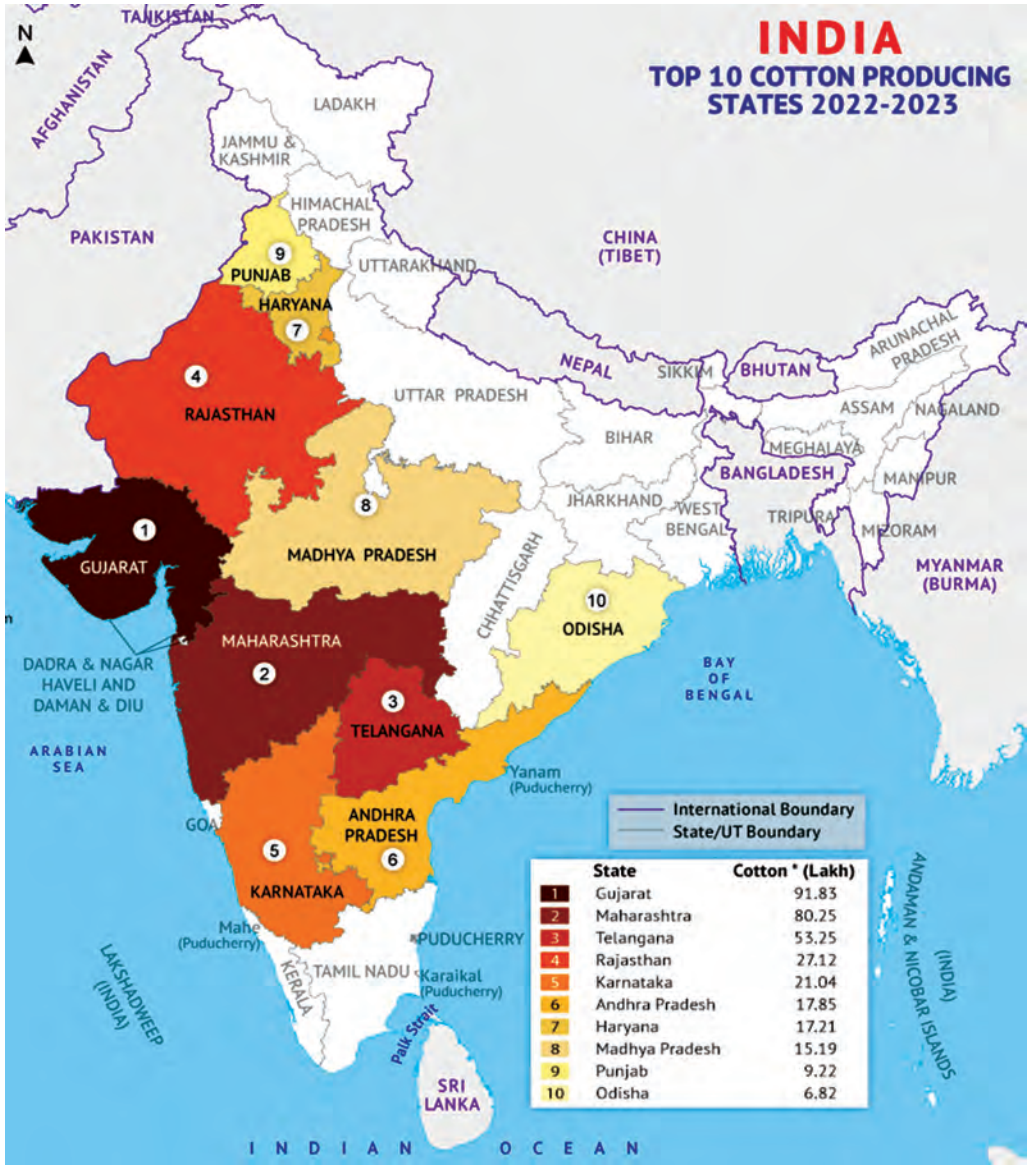


Fig. 9.4: Top 10 Cotton Producing States in India 2022-23

outsourcing landscape, particularly in labour-intensive industries like garments and home textiles.

- **Design and Fashion Capabilities:** Key strengths in design and fashion have empowered Indian players to enhance their partnerships with global retailers, outperforming their Chinese counterparts. India's creative prowess becomes a distinguishing factor in the global market.
- **Production Facilities:** Comprehensive production facilities span the entire textile value chain in India, from spinning to garment manufacturing. The industry is actively investing in technology and expanding its capacities, presenting a significant asset for future growth.
- **Major Players:** Leading Indian corporations such as Arvind Mills, Welspun India, Alok Industries, and Raymonds have solidified their positions as 'quantity producers' on the global stage. These industry giants contribute significantly to India's prominence in the global textile market.

Challenges of Cotton Industry

- Partition and a lag in raw cotton production have led to a significant reliance on imports for long-staple cotton.
- Most mills operate with outdated machinery, impacting productivity and quality.
- A small fraction of looms are automated compared to global standards, hindering efficiency.
- Strong competition from powerlooms, handlooms, synthetic fibres, and foreign products poses a challenge.
- The industry has numerous **"sick mills,"** with a high number already closed, raising concerns about its overall health.

The Current Cotton Production in India is facing challenges. Why?

- **Bt Cotton and Pink Bollworm Resistance:**
  - The adoption of Bt technology significantly boosted cotton production between 2000-01 and 2013-14. Bt cotton, engineered with genes from Bacillus thuringiensis, was effective in controlling the American bollworm.
  - However, the **pink bollworm, a monophagous pest** feeding mainly on cotton, developed resistance to Bt proteins over time.
    - This resistance was accelerated by the short life cycle of the pink bollworm, allowing it to complete multiple generations within a single crop season.
- **Shift in Pest Dominance:**
  - While Bt cotton remained effective against the American bollworm, the increased prevalence of the pink bollworm became a significant threat to cotton crops. Unlike the American bollworm, the pink bollworm's early infestation, starting as early as 40-45 days after sowing, impacted the crop's yields and lint quality.

Government Initiatives

- **Indian government implements policies to boost textile exports:** 100% FDI allowed, establishment of textile machinery champions, emphasis on technology upgradation.
- **Amended Technology Upgradation Funds Scheme (ATUFS)** extends Credit Linked Capital Investment Subsidy (CIS) for export promotion under "Make in India."
- **North-East Region Textile Promotion Scheme (NERTPS)** supports industry in North-East India with infrastructure and marketing assistance.
- **Scheme for Capacity Building in the Textile Sector (SAMARTH)** focuses on skill development and training in textile value chain.

Way Forward

- Adopting improved varieties of cotton seeds that are resistant to pests, diseases, and drought, and have higher yield and quality potential.
- Enhancing the use of technology and innovation in the cotton sector, such as precision agriculture, digital platforms, biotechnology, and nanotechnology, to improve efficiency, quality, and traceability.

Jute Industry: World

Jute is a natural fibre that is used for various purposes, such as making burlap, gunny bags, carpets, and ropes. Jute is the second most important vegetable fibre in the world, after cotton, in terms of global consumption and production. The jute trade is mainly centred around India and Bangladesh, which are the largest producers and exporters of jute and jute products in the world. India produces about 60% of the world's jute, while Bangladesh produces about 40%. Jute is also grown in China, Pakistan, and other countries, but in smaller quantities.

- Jute has a long history of cultivation and trade in the East Bengal region, which is now divided between India and Bangladesh. Jute was exported to Europe by Dutch, French, and British merchants from the 17th century onwards.
- Jute became a major export commodity in the 19th century, when it was used for making sacks, ropes, and other products for the industrial revolution. Jute was also used for military purposes, such as making sandbags and uniforms, during the World Wars.

Geographical distribution of Jute Industry in the Asia

- **Indian Subcontinent (India and Bangladesh):**
  - **India and Bangladesh** are the largest producers and exporters of jute in the world.

- **The Ganges-Brahmaputra** delta in this region provides an ideal environment for jute cultivation, with its hot and humid climate, fertile alluvial soils, and abundant water resources.
- The traditional knowledge and expertise in jute cultivation have been passed down through generations, making these countries major players in the jute industry.

❑ **Asia (China and Thailand):**
- **China and Thailand** are also significant contributors to the global jute industry.
- Similar to the Indian subcontinent, these regions have suitable climatic conditions, including warm temperatures and high humidity, necessary for successful jute cultivation.

❑ **Together, India, Bangladesh and China account for over 90%** of global jute output, reflecting their dominance as premier jute cultivators worldwide.
- India is the world's largest producer of raw jute and jute goods, contributing to over 50 percent and 40 percent respectively of global production.

Jute Industry: India

The Jute Industry in India is the second most significant textile sector after cotton textiles. This industry plays a crucial role in the Indian economy, as it serves as a significant source of employment, directly engaging 2.6 million industrial workers and 1.4 million in the tertiary sector.

However, **Bangladesh** leads in global jute exports, accounting for three-fourths, while **India** contributes about 7%. The industry is labour-intensive, with **West Bengal** being the primary hub, and the majority of jute production is consumed domestically, meeting over 90% of the total demand.

Evolution of Jute Industry in India

❑ Evolution from handloom to large-scale manufacturing in Calcutta in 1855.

❑ Introduction of power looms and advancements in spinning and weaving.

❑ 1947 partition of India led to the challenges due to loss of jute-growing land to East Pakistan.

❑ Post-independence, India underwent a transformative phase, adapting to the challenges posed by the partition and emerging as a hub for diverse industries, contributing significantly to India's economic growth.

Factors Affecting the Jute Industry

❑ **Historical Factors:** The partition of India in 1947 led to the separation of jute-growing areas in East Pakistan from jute-processing mills in West Bengal, disrupting the supply chain and increasing costs for Indian mills. British colonial policies favored the jute industry in Dundee, Scotland, imposing tariffs on Indian products, restricting technology transfer, capital flow, and discouraging diversification and modernization of the Indian jute industry.

❑ **Climate:** Jute cultivation thrives in specific climatic conditions. The optimal temperature for successful jute growth ranges between 24 to 37 degrees Celsius. High humidity levels and sufficient rainfall are also essential. West Bengal, Bihar, and Assam in India offer favourable climatic conditions for cultivating jute.

❑ **Soil:** The quality of the soil is a pivotal factor influencing successful jute cultivation. Well-drained soil with a high water-holding capacity is crucial for jute crops. The alluvial soil in the Ganges-Brahmaputra delta, spanning West Bengal and Bangladesh, is deemed most suitable for cultivating jute.

❑ **Availability of Water:** Jute cultivation demands a significant water supply. The presence of water plays a critical role in successful jute farming. Regions with consistent access to water, such as the Ganges-Brahmaputra delta in West Bengal and Bangladesh, leverage their network of rivers and canals to provide essential irrigation for jute cultivation.

❑ **Proximity to Markets:** Proximity to markets is paramount in the jute industry, given the perishable nature of the commodity. Regions with convenient access to markets are optimal for jute cultivation, ensuring swift and efficient transportation to markets. Jute-growing areas in West Bengal and Bihar, India, are strategically located near major cities like Kolkata, Delhi, and Mumbai.

❑ **Transportation:** Transportation infrastructure plays a pivotal role in the jute industry. Regions with well-established transportation networks, including railways, roads, and ports, are ideal for jute cultivation. Jute-growing regions in West Bengal and Bihar, India, benefit from proximity to major transportation hubs such as Kolkata port and the national highways.

❑ **Electricity**: Coal is mined in the Raniganj fields, which are only 200 kilometers from the Ganga-Brahmaputra region.

❑ **Government Policies:** Government policies and interventions: The government of India has taken several steps to support and protect the jute industry, such as the **Jute Packaging Materials Act, 1987**, which mandates the use of jute for packaging certain commodities, the Jute Technology Mission, which aims to upgrade the technology and infrastructure of the industry, and the Minimum Support Price, that ensures a fair price for the jute farmers.

India's Status

Indian Dominance in the Jute Industry

- **Global Leadership:** India is the global leader in **raw jute** and **jute product** production, contributing about 70% of the world's output.
- **Export Dynamics:** While ranking second in global **jute goods exports**, India trails behind Bangladesh. Despite being in the second position, India's jute exports show a commendable 9% Compound Annual Growth Rate (CAGR) between 2015-16 and 2020-21.

Regional Insights

Key Cultivation States

- **West Bengal:** Boasts the largest jute cultivation acreage in India, contributing to around 50% of the country's total production. Districts like 24 Parganas, Murshidabad, and others are major contributors.
- **Assam:** Focuses jute cultivation in districts like Goalpara, Kamrup, Nowgong, and Tejpur.
- **Bihar:** Jute production is centered in the Purnea district.
- **Odisha:** Cuttack district is the primary jute-producing area.
- **Uttar Pradesh and Maharashtra:** Minimal cultivation observed, with some production in coastal districts of Maharashtra.

Current Industry Status

- **Production Decline:** The Union Ministry of Agriculture and Farmers Welfare reported a decline of over 13% in **jute production** from 2011-12 to 2021-22, dropping from 2.03 million metric tonnes to 1.77 million metric tonnes.
- **Cultivation Area Trends:** According to a 2021 report from the **Commission for Agricultural Costs and Prices (CACP)**, the average area dedicated to **jute cultivation** decreased from 0.82 million hectares (2000-01 to 2009-10) to 0.73 million hectares (2010-11 to 2019-20).
- **Reasons for Decline:** Farmers have shifted away from jute cultivation since 2011, opting for **horticulture crops**.
- **Challenges in the Retting Process: Lack of Resources:** During the crucial **retting process**, which imparts shine and strength to the jute fibre, Indian farmers face challenges due to a lack of access to clean, slow-moving water bodies such as rivers.

Success of Jute Industries: Bangladesh vs. India

While both India and Bangladesh are major players in the global jute industry, their approaches and levels of success differ significantly. Here's a comparative analysis:

Factors Favouring Bangladesh

- **Natural Advantages:** Bangladesh's ideal climate and smaller landmass dedicated to jute cultivation lead to higher yields and potentially lower costs.
- **Government Support:** Strong export-oriented policies, R&D investments, and public-private partnerships drive competitiveness and innovation.
- **Labour Cost Advantage:** Lower wages and a skilled workforce contribute to cost-effectiveness and product affordability.
- **Value Addition:** Focus on product diversification, branding, and eco-friendly production creates market differentiation and potentially higher profits.

Factors Favoring India

- **Production Scale**: The world's largest jute producer, offering higher output and diverse product range.
- **Domestic Market:** Large domestic demand provides stability and growth potential.
- **Diversification:** Established presence in textiles, carpets, and composites beyond traditional products.

Challenges for India

- **Limited Export Focus:** Less emphasis on export promotion compared to Bangladesh.
- **Higher Labour Costs:** Eroding the cost advantage in jute product manufacturing.
- **Fluctuating Domestic Demand:** Domestic demand vulnerability to economic instability.
- **Quality Issues:** Concerns about retting practices and inconsistent fiber quality.

Overall Comparison

- **Export Performance:** Bangladesh currently holds the edge in jute exports due to its focus, government support, and lower costs.
- **Product Diversification:** Bangladesh leads in value-added products, while India holds the diversification advantage in diverse jute applications.
- **Sustainability:** Bangladesh actively promotes sustainable practices, potentially appealing to eco-conscious consumers.
- **Challenges:** Both face infrastructure and competitiveness challenges, but India needs to address domestic demand fluctuations and quality issues.

While Bangladesh excels in exports and value addition, India boasts a larger production scale and domestic market potential. Both can learn from each other's strengths. Bangladesh could expand its domestic market, and India could strengthen its export focus and quality control.

Continued innovation, diversification, and addressing individual challenges will determine the future success of each nation's jute industry.

Challenges of Jute Industry

- **Global Market Dynamics:**
  - **Bangladesh Dominance:** India lags behind Bangladesh in producing high-quality jute fiber. Bangladesh holds a staggering 75% share of global jute exports, while India's contribution is restricted to a mere 7%.
- **Competitive Pricing Issues:**
  - **Cost Disparities:** The cost of jute products surpasses that of synthetic fibres and packing materials, especially nylon. This cost differential has led to a decline in the market share of jute products.
- **Procurement Challenges:**
  - **High Procurement Costs:** Jute mills face challenges with high procurement costs, acquiring raw jute at prices that often exceed what they receive after processing. This cost dynamic impacts the industry's overall profitability.
- **Dependency on Imports:**
  - **Raw Material Imports:** India heavily depends on imports from countries like Bangladesh, Brazil, and the Philippines to fulfill the industry's demand for raw jute. This external dependency raises concerns about the country's self-sufficiency in ensuring an adequate supply of raw jute.

Government Initiatives

- **Jute Packaging Materials Act (1987):** Under this Act, the government issues orders from time to time for the mandatory use of jute packaging.
- **Technical Textiles Mission:** This mission, including Jute Geo-Textiles, focuses on using jute in civil engineering, erosion control, road construction, and riverbank protection.
- **Jute SMART Initiative:** Launched for transparency in jute procurement, enhancing the efficiency of government agencies.

These initiatives collectively aim to enhance the jute industry's sustainability, promote eco-friendly alternatives to synthetic materials, and support the welfare of jute farmers.

Way Forward

- **Market diversification:** Exploring new market segments and applications for jute products beyond traditional uses can help expand the industry's customer base.
- **Technology upgradation:** Adopting modern machinery and technology can improve the productivity and competitiveness of Indian jute mills.
- **Innovation and research:** Developing new and improved varieties of jute, as well as innovative and eco-friendly products, can boost the demand and profitability of the industry.

Do You Know?

- **Technical Textiles:** Technical textiles are defined as textile materials and products used primarily for their technical performance and functional properties rather than their aesthetic or decorative characteristics. Examples: Reinforcement fabrics, Tents, sleeping bags, Industrial belts, Fishing nets, Conveyor belts.
- **Jute Geo-Textiles:** Jute geotextiles are economical, high-strength, and customizable products used in road construction, river bank reinforcement, and agricultural slope stabilization.

Sugar Industry: World

Sugar, with roots dating back 10,000 years to New Guinea, has a rich history. Its cultivation spread across Southeast Asia, India, China, and the Middle East, where it was used for medicine, rituals, and sweetening. Traded on routes like the Silk Road, sugar reached Europe and Africa. The 15th century discovery of the Americas introduced sugarcane, flourishing in the Caribbean and Brazil through plantation agriculture and slave labour. This spurred industries like rum and cotton.

The 18th and 19th centuries brought technological advancements like the steam engine, improving sugar production. The abolition of slavery and independence movements disrupted labour and trade, while sugar beet emerged as a competitor. The 20th and 21st centuries marked global expansion and diversification in the sugar industry, facing challenges such as environmental impact, health concerns, and regulatory issues.

Global Distribution of Sugar Industry

Brazil

- The foremost global producer of sugarcane is Brazil, securing the top position with 40 percent. Sugarcane/ Brazilian Farmers more than half of Brazil's sugarcane is cultivated in Sao Paulo and the surrounding regions.

China

- China ranks as the world's third-largest producer (India- the second) of sugarcane, contributing 6.83% to the global production of sugarcane.
- Significant provinces for sugarcane cultivation in China include Kwangtung, Kwangsi, Fukien, Chekiang, Hunan, and Szechwan.

Thailand

- Thailand's sugarcane production in 2020 amounted to approximately 644 lakh metric tons, constituting 4.13% of the global sugarcane production.

Sugar Industry: India

India is a significant producer of sugarcane and cane sugar, **ranking second in agro-based industries after cotton textiles.** It also **holds the second position globally in sugar production,** following Brazil. The modern sugar industry in India originated when British indigo planters shifted their focus due to declining indigo demand. Over 80% of sugarcane production in India occurs in tropical and subtropical regions due to favourable climate conditions.

However, the sugar industry's foundation lies in sugarcane, a raw material that presents several challenges, hence geographical proximity is vital for the industry's efficiency.

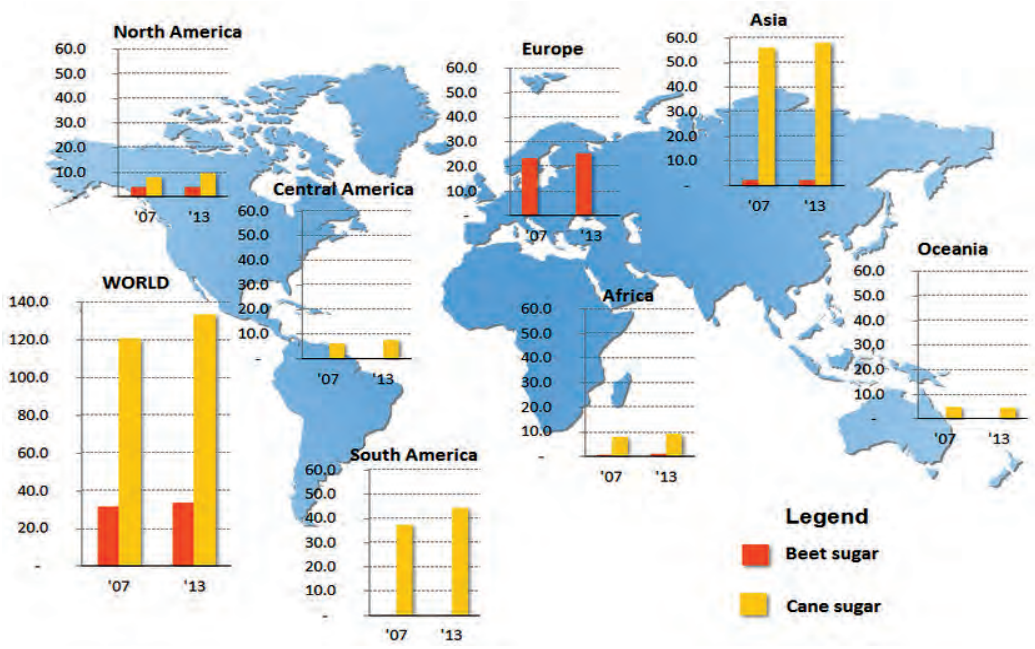


Fig. 9.5: Global Distribution of Sugar Industry

Factors Affecting Sugar Industry

The establishment of a sugar industry depends on several critical factors:

- **Proximity to Sugarcane Growing Area:** Sugar mills are typically located near sugarcane cultivation areas to minimize transportation costs and ensure timely processing.
- **Climate**: The industry thrives in tropical and subtropical regions with suitable rainfall and sunshine for optimal sugarcane growth.
- **Labour Availability:** A skilled and unskilled workforce is essential for tasks like harvesting and processing.
- **Transportation Availability:** Efficient transportation infrastructure is crucial for moving sugarcane from fields to mills and distributing sugar products.
- **Government Incentives:** Government policies and incentives, such as subsidies and tax benefits, can significantly impact the industry's establishment and growth.

Geographical Distribution of Sugar Industry in India

The sugar industry in India is broadly distributed across two major regions:

- **North India:** Uttar Pradesh, Bihar, Haryana, Punjab
- **South India:** Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh & Telangana

These regions account for the majority of sugarcane cultivation and sugar production in the country. However, there are also some sugar mills located in other states, such as Gujarat, Madhya Pradesh, and Odisha.

Fig. 9.6: Statewise Sugar Production

Shifting Trends of Sugar Industry: North To South India

These factors collectively explain the shift in India's sugar production from North to South.

- **Climate Advantage:** The tropical climate in South India provides better conditions for sugarcane cultivation, resulting in higher yields per unit area compared to the north.

- **Higher Sucrose Content:** Sugarcane varieties in the South typically have a higher sucrose content, making them ideal for sugar production.
- **Extended Crushing Season:** South India benefits from a longer crushing season, lasting 7-8 months, compared to the shorter 4-month season in the north.
- **Cooperative Success:** The cooperative movement in peninsular India has been more successful, with better-managed cooperative sugar mills.
- **Politicization Impact:** Political involvement in cooperatives has helped farmers negotiate for better prices and State Advised Prices (SAP).
- **Modern Machinery:** Many mills in the South are equipped with modern machinery, enhancing productivity.

Challenges of the Sugar Industry

- **Land Competition: Competing Crops:** Sugarcane faces competition for agricultural land from other crops like cotton, oilseeds, and rice.
- **Production Fluctuations: Price Volatility:** Fluctuations in sugar production contribute to price volatility, leading to losses during surplus production.
- **Payment Delays and Relations: Delayed Payments:** Sugar mills often delay payments to farmers, causing financial distress. Fair pricing and timely payment disbursal are crucial for maintaining good farming community relations.
- **Seasonal Production Challenges: Seasonal Nature:** Sugar production in India is seasonal, resulting in financial losses for workers and underutilization of mills during the offseason.
- **Low Recovery Rate: Below 10% Recovery:** The sugar recovery rate in India is below ten percent,, posing challenges in terms of production costs.

Legislations

- **Sugar Industry Protection Act:** Enacted in 1932, this legislation aimed to provide protection to the domestic sugar industry, leading to self-sufficiency by 1935.

Government Initiatives

- **Sugar Deregulation (2013-14):** The Central Government abolished mill levy requirements and the regulated release mechanism, aiming to enhance the financial viability of sugar mills and ensure timely payments to sugarcane growers.
- **The FRP of sugarcane for season 2023-24** (October to September) will be ₹340/quintal for a basic recovery rate of 10.25 per cent. Earlier, it was ₹315/quintal.
- **Ethanol Production Incentives:** Incentives for ethanol production from B-heavy molasses and cane juice have been introduced to redirect sugar surpluses towards biofuel production.
- **Biofuel Policy (2018):** The government advanced the target of 20 per cent ethanol blending in petrol from earlier 2030 to 2025.

Current Status of Sugar Industry in India:

- **Global Leadership:** India holds the top position globally as the leading producer, consumer, and second-largest exporter of sugar.
- **Production Growth (2022):** According to the Indian Sugar Mills Association (ISMA), India witnessed a 3.69% increase in sugar production during the October-December quarter of 2022, reaching 12.07 million metric tonnes.
- **Total Production (January 2023):** Post-diversion for ethanol manufacturing, the total sugar production grew to 193.5 lakh metric tonnes as of January 2023, marking an increase from 187.1 lakh metric tonnes in the corresponding period of the previous year.

Rangarajan Committee Report

The Committee was established in 2014 to provide suggestions on the regulation of the sugar sector. It has made the following recommendations:

- **Policy Reforms**: To remove quantitative import and export restrictions on sugar and to replace them with appropriate tariffs.
- **FRP Mechanism:** Proposed the mechanism to set the price of cane that takes into account the cost of sugar and other byproducts.
- **Safeguarding Farmers:** Creation of a dedicated fund through cess, levies, which can close the shortfall if the formula-based cane price falls below what it regards as a suitable payment.

Concept of Fair Remunerative Price (FRP)

- The lowest cost at which sugar mills must purchase sugarcane from farmers is known as the **Fair and Remunerative Price (FRP).**
- According to the recommendations of the Commission for Agricultural Costs and Prices (CACP), **the FRP is determined by the Union government's Cabinet Committee on Economic Affairs (CCEA)**.
- The Sugarcane (Control) Order, 1966 specifies how to determine the sugarcane's "FRP." The recommended FRP is determined by taking into account a number of variables, such as **the cost of production, the demand-supply situation, local and international pricing, inter-crop price parity, etc**.

Silk Industry: World

The silk industry is a global sector that involves the production, processing, and trade of silk and silk products. Silk is a natural fibre that is obtained from the cocoons of silkworms, mainly the mulberry silkworm. Silk is valued for its lustrous appearance, soft texture, strength, and versatility. Silk is used for various purposes, such as clothing, textiles, cosmetics, medicine, and art.

- According to the statistics, the major silk producing countries in the world are China, India, Uzbekistan, Brazil, Japan, Republic of Korea, Thailand, Vietnam, DPR Korea, and Iran.
- China is the **world's largest producer** and exporter of silk, accounting for about 80% of the global silk output.
- India is the **second largest producer** and the largest consumer of silk in the world. The global silk market was valued at $15.6 billion in 2021, and is projected to reach $34.1 billion by 2031, growing at a CAGR of 8.2% from 2022 to 2031.

Global Distribution of Silk Industry

- **Global Silk Production:** Primary silk-producing countries include China, India, Uzbekistan, Brazil, Japan, Republic of Korea, Thailand, Vietnam, DPR Korea, Iran, among others.
- **Major Silk Consumers:** Worldwide, major silk consumers include the USA, Italy, Japan, India, France, China, United Kingdom, Switzerland, Germany, UAE, Korea, Vietnam, etc.
- **Global Market Share:** Silk constitutes less than 0.2% of the global textile market, though the precise value is difficult to ascertain due to data limitations on finished silk products in many importing countries.
- **Geographical Distribution and Recent Developments:** Silk production spans across 60 countries, with Asia housing the majority of producers (90% for mulberry and nearly 100% for non-mulberry silk).
- **Employment in Silk Sector:** Approximately 1 million workers are employed in the silk sector in China, making it the world's largest producer and primary supplier of silk. India follows as the second-largest producer.

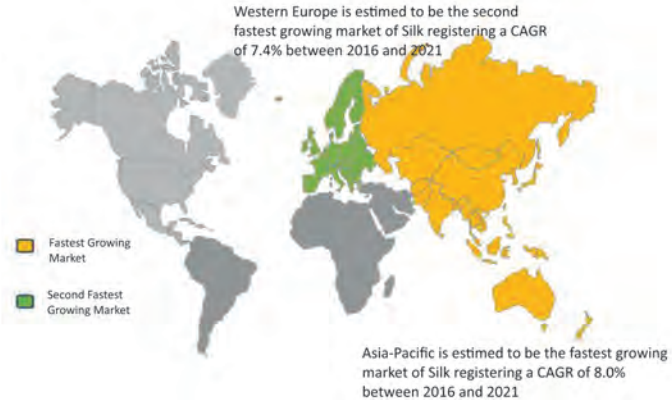

Western Europe is estimed to be the second fastest growing market of Silk registering a CAGR of 7.4% between 2016 and 2021
Fastest Growing Market
Second Fastest Growing Market
Asia-Pacific is estimed to be the fastest growing market of Silk registering a CAGR of 8.0% between 2016 and 2021

Fig. 9.7: Global Distribution of Silk Industry

Silk Industry: India

The Indian silk industry is a significant and diverse sector that spans both agriculture and textiles. **India ranks as the world's second-largest producer of silk,** following China, and is known for its wide variety of silk types, including **Mulberry, Tussar, Eri, and Muga silk**.

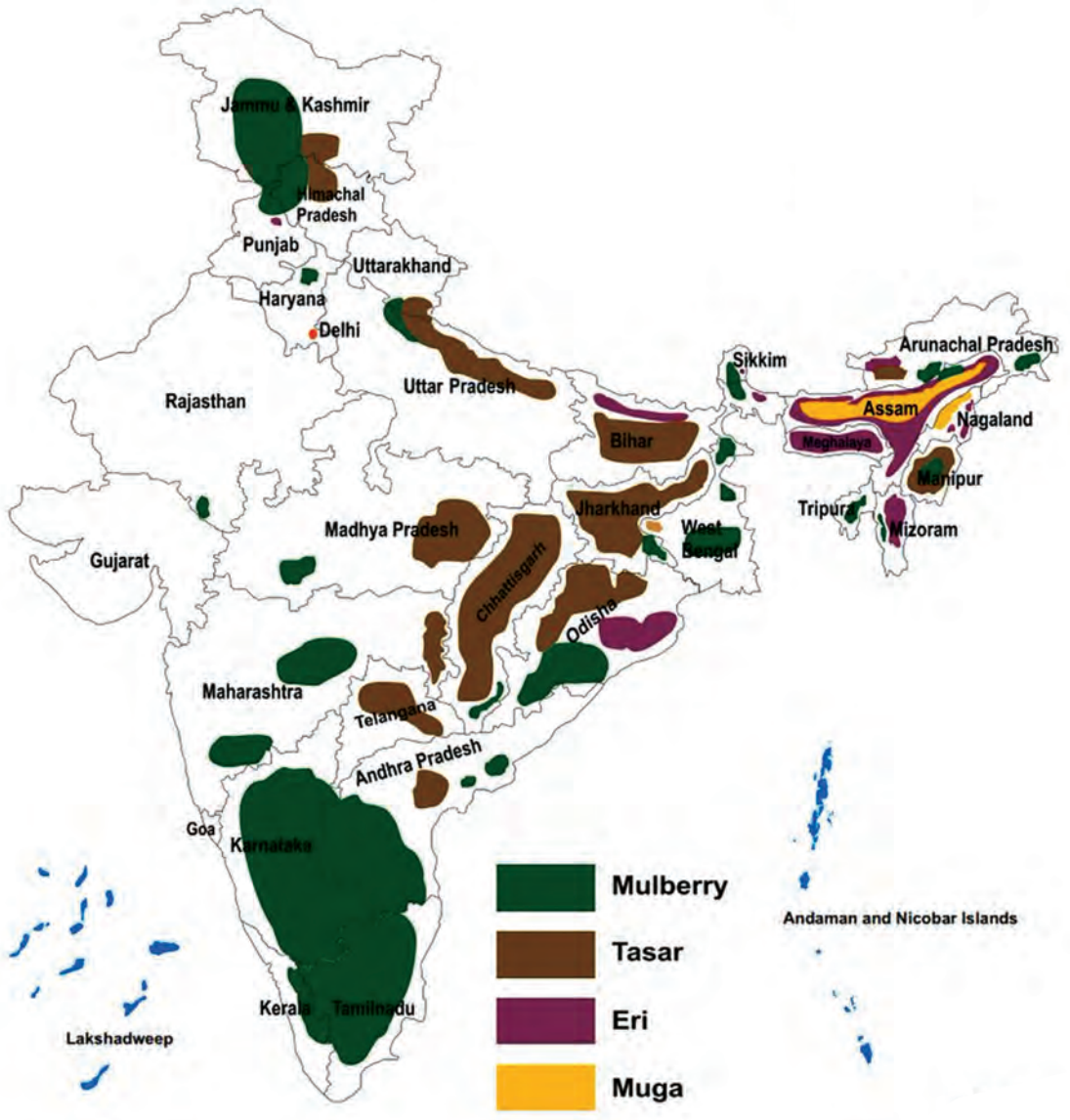
- Sericulture activities are spread across a vast network of many 52,000 villages, **providing employment to more than 8.7 million people in both rural and urban areas.** This industry plays a crucial role in India's foreign exchange earnings, with exports of raw silk, silk yarn, silk fabrics, and garments reaching international markets, including the United States, the European Union, Japan, and the Middle East.
- The government actively supports sericulture through initiatives and schemes aimed at boosting production, enhancing quality, and improving the livelihoods of those involved in silk farming and weaving. The Indian silk industry not only contributes economically but also showcases the rich cultural heritage and artisanal skills of the country.

Geographical factors for Location of Silk Industry

- **Climate:** Suitable for the growth of various silk varieties, temperate and tropical climates contribute to silk production. For example, the Lower Yangtze Valley is renowned for producing high-quality white mulberry silk.
- **Labour**: Affordable female labour is a crucial requirement for sericulture. In ancient and medieval times, both China and Japan had a surplus of impoverished peasants for whom silk production became a significant source of income.
- **Skill and Institutions**: Lyon in France has become a notable fashion center due to the presence of skilled labour and a wealth of fashion designers.
- **Technology:** Chinese scientists have developed hybrid silk varieties by combining Japanese and European silkworms. This advancement allows for the rearing of silkworms up to seven times a year.
- **Raw Material:** Silk, being easy to transport, non-perishable, and non-bulky, can be readily imported from China.
- **Market and Demand**: Considered a luxury item and a fashion statement among the affluent in the US and Europe, there is a substantial demand for silk ties, scarves, and lingerie.
- **Investment Trends:** Investors have found more lucrative returns in the automobile and electronics industries, resulting in a lack of investment in the silk industry.
- **Technological Shifts**: After World War I, silk was highly sought for women's stockings in the USA. However, the market later shifted towards locally produced, more affordable stockings made from American nylon.
- **Competition and Industry Transformation:** The decline of the silk industry in Koromo town, Japan, led to an opportunity for transformation. Cheap land and labour attracted Toyota, turning a rural silk-producing area into a major hub for the automobile industry.

Favourable factors for Silk Industry in India

- **Labour:** Sericulture is not labour-intensive, as silkworms can be easily reared by women and older individuals. In the Eastern States, farmers who were previously involved in jute cultivation shifted to sericulture as the demand for jute declined.
- **Raw Material:** The climate supports the easy growth of mulberry, and the Bombax variety of silkworms can be reared throughout the year.
- **Technology:** Karnataka utilizes hybrids of silkworms, allowing for harvesting five to six times a year. However, the widespread adoption of such varieties is not uniform across all growing regions.
- **Investment:** Sericulture operates on simple technology, requiring no sophisticated equipment. Small and marginal farmers, as well as tribals, can engage in sericulture.
- **Market:** Silk sarees remain popular in India, contributing to a steady market for sericulture.
- **Skill and Institutions:** The Central Silk Board is located in Bangalore, serving as a key institution in the field of sericulture. Technical knowledge is shared through collabourations such as the one with the Japanese International Cooperation Agency (JICA)



Mulberry Silk
Andhra Pradesh
Arunachal Pradesh
Assam
Bihar
Chhattisgarh
Haryana
Himachal Pradesh
Jammu & Kashmir
Jharkhand
Karnataka
Kerala
Madhya Pradesh
Maharashtra
Manipur
Meghalaya
Mizoram
Nagaland
Odisha
Punjab
Rajasthan
Sikkim
Tamil Nadu
Tripura
Uttarakhand
Uttar Pradesh
West Bengal

Vanya Silk
Tasar Silk
Andhra Pradesh
Bihar
Chhattisgarh
Jharkhand
Madhya Pradesh
Maharashtra
Odisha
Telangana
Uttar Pradesh
West Bengal

Oak Silk
Arunachal Pradesh
Manipur
Mizoram
Nagaland
Jammu & Kashmir
Uttarakhand

Eri Silk
Andhra Prdesh
Arunachal Pradesh
Asam
Bihar
Chhattisgarh
Jharkhand
Madhya Pradesh
Manipur
Meghalaya
Mizoram
Nagaland
Odisha
Punjab
Sikkim
Uttar Pradesh
West Bengal

Muga Silk
Arunachal Pradesh
Assam
Manipur
Meghalaya
Mizoram
Nagaland
West Bengal

Fig. 9.8: Silk Industry in India

Geographical Distribution of Silk Industry in India

State	Cities/Districts
Andhra Pradesh	Dharmavaram, Pochampalli, Venkatagiri, Narainpet, Karimnagar, Warangal, Mahbubnagar, Kurnool, Ongole, Adilabad, Hindupur
Assam	Sualkuchi
Bihar	Katihar and Bhagalpur
Gujarat	Surat, Cambay
Jammu & Kashmir	Srinagar
Karnataka	Bangalore, Anekal, Ilkal, Molakalmuru, Melkote, Kollegal, Tumkur, Doddaballapur, Mysore

Current Status of Silk Industry in India

India, the **second-largest silk producer** globally, showcased the following silk varieties in 2020-21:

- **Mulberry Silk:** 70.72% (23,860 MT)
- **Tasar Silk:** 8.02% (2,705 MT)
- **Eri Silk:** 20.55% (6,935 MT)
- **Muga Silk:** 0.71% (239 MT)

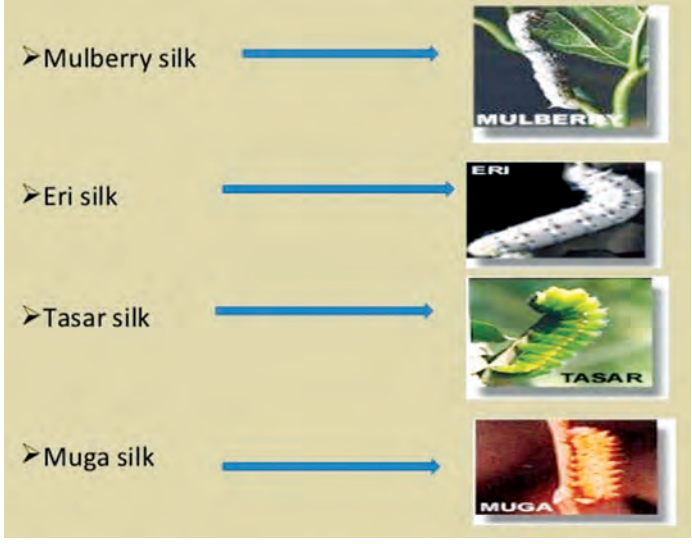


Fig. 9.9: Types of Silk Worms

Total Raw Silk Production

33,739 MT (Provisional), with a reduction in production attributed to **Covid-19 disruptions**.

Demand and Challenges

- Growing demand for high-quality bivoltine silk in India for domestic use and value-added silk products in export markets.
- Challenges include the global economic downturn affecting silk exports, the impact of low-cost Chinese silk, and the decline in mulberry silk cultivation due to **urbanization and industrialization**.

Policy Initiatives

- **National Silk Policy 2020:**
  - Sericulture is recognized as an agriculture allied activity under **RKVY**, extending benefits to sericulturists for all sericulture activities.
  - **CSB (Amendment) Act, Rules, and Regulations** were enacted to establish quality standards in silkworm seed production.
  - Amendments to the **Forest Conservation Act** consider non-mulberry sericulture as a forest-based activity, enabling Vanya silkworm rearing in natural host plantations within forests.
  - **Antidumping Duty Recommendation:** DGAD recommends imposing **antidumping duty** on Chinese raw silk of 3A grade & below, with a fixed duty of US$ 1.85 per Kg on the landed cost.
  - **Convergence Guidelines for CDP-MGNREGA:** Finalized guidelines jointly issued by **MOT and MORD** to assist sericulture farmers in accessing support from thssse **MGNREGA scheme**.

Way Forward

- Emphasis on the development of the silk industry through policy initiatives, recognizing sericulture as an integral part of agriculture and ensuring quality standards in production.
- Measures to address challenges such as **Chinese silk imports**, **urbanization-driven decline** in mulberry silk cultivation, and the need for integrated markets and sericulture knowledge among traders.

Tea Industry: World

Tea Industry Overview

Tea, derived from the **Camellia sinensis** plant, ranks as the **second most popular beverage** globally, with **3 billion cups consumed daily**. The global tea market was valued at around **122.2 billion U.S. dollars in 2022**, and is expected to rise to **160 billion dollars by 2028**.

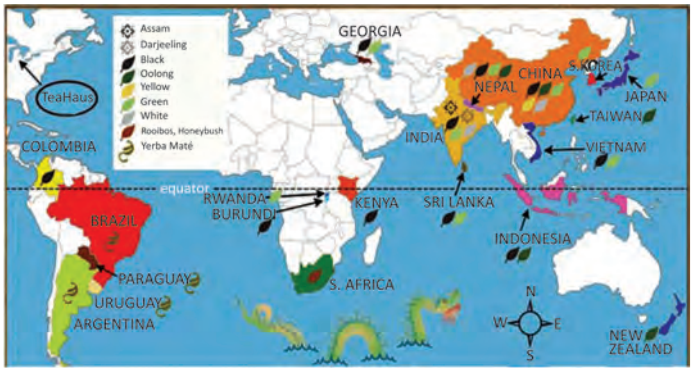


Fig. 9.10: Tea growing regions of the world

Market Growth Drivers

- **Health benefits** of tea consumption.
- Increased awareness about **carbonated drinks**.
- Rise in **disposable income**.
- Shifting consumer tastes.
- Introduction of **healthy ingredients** in tea.

Global Distribution of Tea Industry

- **China:**
  - Largest tea-producing country.
  - Productivity is lower at **700 kg per hectare**.
  - Less commercially oriented due to small-scale and dispersed enterprises.
  - Key producing states: Hupeh, Hunan, Sichuan, Fujran, Kiangai.
  - Known for various tea types like **green tea, Jasmine tea, Wulong tea, and brick tea**.
- **Sri Lanka:**
  - **2 million hectares** dedicated to tea cultivation (15% of cultivable land).
  - Moderate productivity at **1,250 kg per hectare**.
  - Major tea gardens in **Kandy, Gale, Matara, Badulla, and Nuwara Eliya**.
  - **Second-largest tea exporter globally**.
- **Japan:**
  - Specializes in **green tea** production.
  - Contributes **3.5%** to global tea production.
  - Notable regions: **Uji, Shizuoka Hida, Kyushu Island**.
  - Exports a portion of tea production.

Locational Factors Affecting Tea Industry

- **Labour availability:** Tea cultivation and processing require a cheap and skilled female labour force for tasks such as weeding, manure, pruning and plucking. Tea plantations are usually located near areas with a high population density.
- **Climate:** Tea plants need a warm and humid climate with abundant rainfall and no frost. They also prefer acidic soils and moderate elevation. Tea is not grown beyond Northern China or Honshu in Japan because of the cold winters.
- **Topography:** Tea plants do not like stagnant water, so they have to be grown on highland or hill slopes with good drainage. This also makes mechanization difficult and increases the cost of transportation.
- **Capital availability:** Tea plantations need large-scale investment for land preparation, irrigation, fertilization, pest control, and processing facilities. They also have a long gestation period before they start yielding profits. Therefore, tea plantations are often financed and controlled by commercial companies based in Europe or elsewhere.
- **Market demand:** Tea is a popular beverage in many parts of the world, especially in Europe, India, China, and Japan. The demand for tea influences the location of tea plantations, as well as the type and quality of tea produced.
  - For example, black tea is preferred by Indians and Europeans, while green tea is preferred by people in the Far East. Tea processing is also done according to market preferences, such as fermentation, roasting, blending, and packaging.

Tea Industry: India

India holds a prominent position in the global tea industry, ranking as the **second-largest producer of tea worldwide.** Remarkably, India is both a major tea producer and one of the world's top consumers of tea, with around 80% of its tea production being consumed domestically.

The northern part of India, primarily **Assam and West Bengal**, contributes significantly to the country's annual tea production, accounting for about 83%. Meanwhile, the southern part, encompassing states like Tamil Nadu, Kerala, and Karnataka, contributes around 17%. The geographical diversity of tea cultivation regions further enhances India's global standing in the tea market.

Geographical Distribution of Tea Industry in India

- Tea cultivation in India is geographically distributed in two separate regions.
- Each region may be sub-divided into sub-regions:

(a) Tea cultivation in North India
  (i) The Darjeeling hills.
  (ii) The Brahmaputra valley.
  (iii) The Dooars.
  (iv) The Surma valley.

(b) Tea cultivation is S.W. India: (i) Nilgiri & (ii) Annamalai

(a) (i) The Darjeeling hills:

- Darjeeling tea gardens are renowned for producing some of the finest quality tea globally.
- The optimal quality of tea is cultivated on well-drained hilly slopes, specifically those situated above 500 meters.
- In this region, tea estates are strategically positioned between the Mechi-Balasan and Mahanadi rivers.
- Despite its exceptional quality, the production of Darjeeling tea grapples with the challenge of unpredictability.

- Darjeeling tea contributes approximately 15 to 20% of the national tea output.

(ii) The Brahmaputra valley:

- The largest tea-producing region in India is found in this area.
- Plantations are extensive, covering districts such as Kamrup, Darrang, Goalpara, Sibsagar, Lakhimpur, and others.
- Tea production in this region faced disruptions in the late 1990s due to factors like socio-political tension, ageing problems with estates, and various other challenges.

(iii) The Dooars

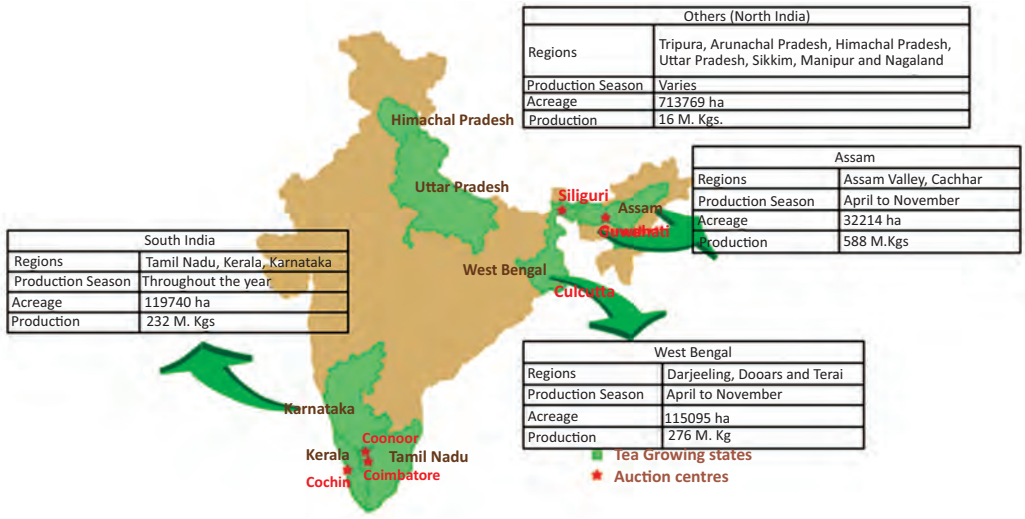
- Tea production is a significant focus in the foothills of the eastern Himalayas.These foothills encompass extensive areas in the districts of Coochbihar and Jalpaiguri.
- Noteworthy tea estates in this region include Madarihat, Nagrakata, Kalchini, and others.

(iv) The Surma valley:

- Surma valley in Assam is a significant producer of tea, having more than 100 tea estates.

(b) Tea Estates in S.W. India:

- The southwestern region of India, which includes parts of Karnataka, Tamil Nadu, and Kerala, extends across extensive areas in the Palni, Cardamom, and Annamalai hills.
- In this region, in contrast to the tea gardens in Northern India, the tea estates are smaller, discontinuous, and result in lower production.



Others (North India)	
Regions	Tripura, Arunachal Pradesh, Himachal Pradesh, Uttar Pradesh, Sikkim, Manipur and Nagaland
Production Season	Varies
Acreage	713769 ha
Production	16 M. Kgs.

Assam	
Regions	Assam Valley, Cachhar
Production Season	April to November
Acreage	32214 ha
Production	588 M.Kgs

South India	
Regions	Tamil Nadu, Kerala, Karnataka
Production Season	Throughout the year
Acreage	119740 ha
Production	232 M. Kgs

West Bengal	
Regions	Darjeeling, Dooars and Terai
Production Season	April to November
Acreage	115095 ha
Production	276 M. Kg

Fig. 9.11: Tea Production in India

- **Productivity and Quality Decline:** The decline in productivity and quality is attributed to the necessity of replanting tea bushes every five years.
- **Poor Worker Conditions and Low Wages:** Despite the provisions of the Plantation Labour Act, 1951, many workers and their families live in unsanitary conditions and receive meager wages.
- **Challenges Faced by Small Tea Growers:**
  - Small Tea Growers (STGs) encounter several challenges, including:
  - Difficulty in obtaining the right green leaf price.
  - Inability to leverage scale and face marketing challenges as a collective due to the unorganized nature of the sector.

IGNITE YOUR MIND

Tea and Tech Convergence: How might advancements in automation and climate-smart agriculture reshape the global tea industry, impacting producers, consumers, and traditional landscapes?

India's Market Size

- In the year 2020, the country consumed almost 1.10 million tons of tea.
- The tea market size in India reached US$ 11.1 Billion in 2023 and it is expected to reach US$ 14.7 Billion by 2032, exhibiting a growth rate (CAGR) of 3.18% during 2024-2032.

Challenges of Indian Tea Industry

- **Stiff Competition and Enhanced Standards in the Global Market:** Intense competition and elevated standards in the global market, driven by the prevalence of low-priced tea from countries such as Kenya, are escalating the demand for organic tea. Quality assurance, including environmental justice, is becoming increasingly pivotal.

Initiatives to Promote Tea Industry

- **Promotion for Packaged Tea of Indian Origin:** The program offers support for promotional campaigns, with a cost reimbursement of up to 25%.
- **Subsidies for Domestic Exporters:** Domestic exporters can benefit from subsidies provided by the Tea Board to participate in international fairs and exhibitions.
- **Tea Development and Promotion Scheme:** Launched in November 2021 by the Tea Board of India for the period 2021-26, this scheme aims to enhance the productivity and quality of tea production in India.
- **Chai Sahyog Mobile App:** The Chai Sahyog Mobile App is designed to address various issues faced by small tea growers.

Tea Board of India

The Tea Board of India is a statutory body under the Ministry of Commerce and Industry, Government of India. It was established on 1 st April 1954 under the Tea Act, 1953. The Board is responsible for the promotion and development of the Indian tea industry.

Its main functions include:

- **Regulating the tea industry:** The Board registers and licenses tea gardens, factories, dealers, and brokers. It also lays down quality standards for tea and enforces them.
- **Promoting Indian tea:** The Board undertakes various promotional activities to promote Indian tea in the domestic and international market. It participates in trade fairs and exhibitions, organizes tea festivals, and conducts market research.
- **Providing financial assistance:** The Board provides financial assistance to tea growers, manufacturers, and exporters for various purposes such as modernization, expansion, and marketing.
- **Conducting research and development:** The Board supports research and development activities in the tea sector to improve productivity, quality, and value addition.
- **Providing welfare services:** The Board implements various welfare schemes for the benefit of tea plantation workers.
- **GI tag for tea industry in India:**

Darjeeling tea became the first GI tagged product in India, in 2004–2005. It is also known as the "Champagne of teas," worldwide because of its flowery scent and unique flavour. The other two variants of Darjeeling tea, i.e., Green and White tea, also hold GI tags.

Other GI-tagged Tea Products in India

- **Assam tea:** Grown in the Brahmaputra valley of Assam, known for its strong, malty, and brisk taste.
- **Kangra tea:** Grown in the Kangra valley of Himachal Pradesh, known for its delicate, floral, and aromatic flavour.
- **Nilgiri tea:** Grown in the Nilgiri hills of Tamil Nadu, known for its fragrant, fruity, and brisk taste.
- **Munnar tea:** Grown in the Munnar region of Kerala, known for its rich, full-bodied, and smooth flavour.
- **Coonoor tea:** Grown in the Coonoor region of Tamil Nadu, known for its bright, lively, and refreshing flavour.

Way Forward

- **Focus on quality and value addition**: The tea industry needs to improve the quality and diversity of its products, and invest in value addition such as branding, packaging, certification, and innovation.
- **Enhance exports and competitiveness:** The tea industry needs to explore new markets and opportunities for exports, and enhance its competitiveness in the global market.
- **Adopt climate-smart practices**: The tea industry needs to adopt climate-smart practices that can help mitigate and adapt to the impacts of climate change.

Coffee Industry: World

Coffee is one of the most popular and widely consumed beverages in the world, with an estimated market value of over $132.13 billion in 2024. Coffee is produced from the seeds of the coffee plant, which grows in tropical and subtropical regions across the globe.

There are two main types of coffee beans: Arabica and Robusta, each with different characteristics, flavors, and prices. Arabica beans are generally considered to be of higher quality and more aromatic, while Robusta beans are more bitter and have higher caffeine content. Arabica beans account for about 60% of global coffee production, while Robusta beans account for about 40%.

THE BEST COFFEE COMES FROM THE BEST GROWING CLIMATES, KNOWN AS
THE BEAN BELT
1 PAPUA NEW GUINEA
Semi-sweet chocolate aroma, cocoa flavor with hints of cherry. Medium body, quick finish.
8 ETHIOPIA
Rich blueberry aroma, cocoa and spice flavor, medium body and clean finish.
PRIME COFFEE-GROWING REGIONS FORM A BELT ROUGHLY BOUNDED BY THE TROPICS OF CANCER AND CAPRICORN. THESE AREAS OFFER PERFECT CONDITIONS FOR GROWING COFFEE BEANS.
2 BRAZIL
Slightly spicy, nutty aroma, nutty base, carmel notes. Full body, clean finish.
4 HONDURAS
Sweet molassas aroma and flavor, full body and lingering sweet finish.
6 GUATEMALA
Sweet, tart aroma, lightly fruity flavor. Light body and clean finish.
3 SUMATRA
Aroma of dried fruit and nuts, full syrupy body, deeply sweet finish.
5 PERU
Bright, fruity aroma, lightly fruity flavor with a clean finish.
7 COLUMBIA
Nutty aroma, caramel flavor. Medium body and heavy finish

Fig. 9.12: Coffee belt of the World

Geographical distribution of Coffee Plantations

- **Brazil:** In addition to cost-effective labour, Brazil enjoys several geographical advantages. Its highlands feature gently rolling terrain with occasional pronounced escarpments, providing excellent drainage.
- **Caribbean Countries:** Approximately one-third of the world's coffee entering global trade originates from the highlands in the countries surrounding the Caribbean Sea.
  - Coffee cultivation areas span from southern Colombia, near the equator, to Cuba and Mexico along the tropical region's margins.
  - The mountain slopes or piedmont plains, situated between 300 and 2000 meters above sea level, create nearly ideal conditions for coffee cultivation.
- **Southeast Asia:** Tropical Southeast Asia stands as a crucial region for coffee production. Before Brazil emerged as the global coffee giant, South Asia was a major contributor to world coffee production.
  - India cultivates coffee in the southern states of Karnataka, Tamil Nadu, and Andhra Pradesh. Sri Lanka predominantly produces coffee in its highland regions.
- **East African Highlands:** The East African Highlands represent the fourth significant region for coffee cultivation. Combined, East and West Africa contribute approximately 20% of the coffee traded internationally.
  - Key coffee-producing nations in this continent include Ethiopia, Kenya, Uganda, Angola, and Ghana.

Coffee Industry: India

- **India is the fifth-largest exporter of coffee in the world during 2021-22**. Due to its excellent premium quality, Indian coffee is among the greatest in the world. **Arabica and Robusta** are the two varieties of coffee produced in India. More than 2 million individuals in India are directly employed by the sector. India mostly exports coffee, therefore domestic demand and consumption have a less significant impact on coffee prices.
- Coffee is primarily grown in the **Southern region of India**. The majority of India's total coffee output, or around 70%, is produced in Karnataka. Despite being the second-largest producer of coffee, Kerala only contributes roughly 23% to India output. With 6% of all cofee, produced Tamil Nadu is the third-largest producer. The Nilgiri district, a significant Arabica growing region, produces about half of Tamil Nadu's coffee.

Important Varieties of Coffee

Coffee Robusta

- Apart from South Asia and Southeast Asia, Robusta coffee, scientifically designated as Coffea canephora, is predominantly cultivated in Africa and Brazil.
- Vietnam has become a leading global producer and exporter of coffee primarily due to the cultivation of Robusta coffee.

Coffee Arabica

- Ethiopia and the Arab world host the Coffea arabica plant, considered the first cultivated type of coffee, commonly known as the Coffee Shrub of Arabia.
- This coffee variety, by nature, contains a relatively low amount of caffeine.

Coffee Liberica

- The Coffea liberica species traces its roots back to Liberia, originating from this region.This shrub has the potential to grow up to 9 meters in height, and its cherries are notably larger.
- In the Philippines, the Barraco cultivar holds significance as a substantial crop.

Coffea charrieriana

- The coffee plant Coffea charrieriana contains no caffeine. In Cameroon, you can find it.

Mocha Coffee

- Mocha coffee or cafe mocha is derived from Coffea Arabica, commonly known as Arabica coffee.
- The term "mocha" finds its origin in a Yemeni town called Mocha.
- During the 15th and 16th centuries, Yemen held the position of being the world's primary producer and exporter of mocha coffee.

Factors Affecting Coffee Cultivation

- **Climate patterns:** Coffee plants require a hot and humid climate with temperatures ranging between 15°C and 28 °C and rainfall from 150 to 250 cm. However, erratic weather conditions such as dry spells, unseasonal heavy rains, floods and landslides have adversely affected the coffee crop in recent years.
- **Pests and diseases:** Coffee plants are susceptible to various pests and diseases, such as white-stem borer, leaf rust, berry borer, etc. These can reduce the yield and quality of the coffee beans. Climate change is also helping pests to breed and new diseases to emerge.
- **Financing:** Coffee cultivation requires a lot of investment in inputs such as fertilizers, pesticides, labour, etc. However, most coffee growers in India are small and medium farmers who face difficulties in accessing credit from banks and other sources. They also have to deal with the low and fluctuating prices of coffee in the global market.
- **Cost of production:** The cost of coffee production in India is high due to the tough terrain where mechanization is restricted. The cost of labour is also rising as there is a shortage of skilled plantation workers. Moreover, the coffee growers have to comply with various environmental and social standards to meet the demands of consumers.

Challenges faced by Coffee Industry

- **Labour Shortage:**
  - **Brazil:** Labour costs constitute **25%** of total production costs.
  - **India:** Planters assert labour costs account for **65%** of total production costs.
- **Electricity Outages:** Summer electricity outages lead to expensive irrigation using high-cost diesel.
- **Climatic Shifts:**
  - **2015-2017:** Dry spells.
  - **2018-2022:** Unusually heavy rains, floods, and landslides.
  - Adverse impact on Indian coffee's market share globally.
- **Global Competition:**
  - Indian coffee faces tough competition, losing market share to countries like Brazil.
  - High production costs and ineffective marketing contribute to this challenge.
- **Ecological Vulnerability:**
  - **Western Ghats:** Primary region for coffee cultivation.
  - Recognized as one of the **top 25 biodiversity hotspots globally**.
  - Poses challenges for promoting coffee farms sustainably.

Production Statistics

- Coffee Arabica, constituting 49% of the area, and Coffee Robusta, covering 51% of the area, stand as the two primary varieties of coffee cultivated in India.
- Karnataka emerges as the leading producer, contributing around 70% of the total coffee production and encompassing 60% of the coffee cultivation area in India.

Schemes for Support

- The RoDTEP (Refund of Duties and Taxes on Exported Products) scheme has recently been expanded by the Centre to include the coffee sector, aiming to enhance export growth.

Way Forward

- Adopting sustainable and climate-smart practices like shade-grown coffee, organic farming, water conservation, and soil management.
- Investing in research, innovation, and technology to enhance productivity, quality, and diversity of coffee varieties while reducing production costs and risks.
- Expanding domestic and international markets by promoting unique Indian coffee flavours and meeting changing consumer preferences like specialty and instant coffee.

Vegetable Oil Industry

- With a variety of oilseed crops cultivated in various agro climatic zones, India is one of the world's top producers of oilseeds. About 8% of the world's oilseed crop is produced in India.
- Vegetable oil has an anticipated demand of over 18mt (million metric tonnes), which is largely satisfied by imports.
- This industry holds a unique place in the Indian economy since it creates chances for employment for millions of people, generates an average domestic revenue of $10 billion annually.

Locational Factors for Vegetable Oil Industry

- **Raw Material Proximity:** Industry clusters near sources like Rajasthan for mustard oil to minimize transport costs and maintain freshness.
- **Energy Costs:** Locations with cheap and reliable power like Gujarat's coal/gas resources attract producers due to high energy demand for processing.
- **Market Access:** Proximity to major consumption centers (West & South India) or export hubs reduces distribution costs and caters to customer preferences.

Leather Goods Industry

- Around 13% of the world's leather hides and skins are produced in India. The sector is among the top ten foreign exchange earners for the nation and is renowned for its regularity in producing significant export revenues.
- The leather industry is an **employment-intensive industry** that employs over 4 million people, the majority of whom come from lower-income families.
- **Women** make up around 40 percent of the workforce. With 55% of the workforce under the age of 35, India's leather sector has one of the youngest workforces. The largest markets for Indian leather & footwear Products include the United States, Germany, the United Kingdom, Italy, France, Spain, the Netherlands, the United Arab Emirates, China, Hong Kong, Belgium, and Poland.

Locational Factors for Leather Goods Industry

- **Raw materials:** The industry relies on cow, sheep, goat, and pig hides, sourced globally based on climate, animal husbandry, and environmental regulations. India contributes significantly, producing 13% of world leather.
- **Consumer demand:** Industry serves diverse segments like fashion, luxury, sports, and casual wear, adapting to changing trends. Vegan leather, made from synthetic or plant-based materials, is gaining popularity among eco-conscious consumers.
- **Competition and innovation:** Face competition from materials like rubber, plastic, and textiles. Embracing technologies like 3D printing, laser cutting, and biodegradable materials to enhance efficiency, quality, and sustainability.

India as Footwear Hub
The country accounts for 13 percent of global footwear manufacturing and is the world's second-largest footwear manufacturer and consumer. For every 1,000 pairs manufactured and sold in India each day, the industry has the potential to generate 425 jobs in manufacturing, adjacent sectors, and retail. In terms of volume, India is predicted to produce over 3 billion units by 2024.

Woolen Industry

- India ranks second in sheep population and accounts for more than 4.03% of the world population (FAOSTAT, 2019) with 74.26 million sheep to its record. Wool production in the country hovers in the range of 43-46 million kg annually. The wool textile industry in India is poised for healthy growth.
- However, it faces a challenge due to insufficient domestic production, a reliance on imported raw materials and other issues such as obsolete machinery, competition with more advanced countries, competition with synthetic fibres, a shortage of power and lack of market.
- Wool production is dispersed across several Indian states, including Karnataka, Jammu & Kashmir, Telangana, Gujarat, Himachal Pradesh, Uttar Pradesh, Haryana, Maharashtra, and Andhra Pradesh. Notably, Rajasthan leads the nation in wool production.

Food Processing Industries: World

The food processing industry is a huge and diverse network of businesses that provide most of the food that people eat around the world. It covers many different activities, from simple methods like drying and salting to more advanced ones like fermentation, milling, and packaging. The industry has a key role in ensuring food security, reducing food waste, and creating jobs.

Leading Regions

- **European Union**: The EU is the world's top producer of processed food and drinks, making up about 44% of global sales. The industry is especially strong in Germany, France, Italy, and Spain.
- **United States**: The US is the world's second-largest producer of processed food and drinks, with a 20% share of the global market. The industry is mainly located in California, Texas, and Illinois.
- **China**: China is the world's third-largest producer of processed food and drinks, with a 19% share of the global market. The industry is growing fast, driven by urbanization and rising incomes.

Key Sectors

- **Meat processing**: This sector involves the killing, packing, and processing of meat products such as beef, pork, poultry, and lamb.
- **Dairy processing**: This sector involves the collection, processing, and packaging of milk and milk products such as cheese, yogurt, and butter.
- **Fruits and vegetables processing**: This sector involves the cleaning, sorting, chopping, canning, freezing, and drying of fruits and vegetables.
- **Grain processing**: This sector involves the milling, grinding, and packaging of grains such as wheat, rice, and corn.
- **Beverage processing**: This sector involves the production of soft drinks, alcoholic drinks, and bottled water.

Locational Factors for Food Processing Industry

- **Proximity to Raw Materials:**
  - **Fruits and Vegetables:** Maharashtra, a leading producer of grapes, tomatoes, and onions, has numerous processing plants for these items. Similarly, Karnataka's proximity to mangoes and coconuts attracts processing units.
  - **Milk:** Punjab, being a major milk producer, houses many dairy processing plants like Amul and Verka.
- **Proximity to Markets:**
  - Ready-to-eat meals: ITC's "Bingo!" snack plant in Munger, Bihar, caters to the eastern Indian market's demand for convenience foods.
  - Marine products: Processing units in Kochi, Kerala, capitalize on proximity to fishing harbors and export markets.
- **Availability of labour:**
  - Textile-based food processing: The textile hub of Tirupur, Tamil Nadu, also houses units processing textile byproducts like soy chunks, utilizing the readily available skilled workforce.
  - Spice processing: Alleppey in Kerala, known as the "Spice Coast," has a long history of spice processing due to its skilled workforce and abundant spices.
- **Transportation Infrastructure:**
  - **Mega Food Parks:** The Indian government established Mega Food Parks near transport hubs like rail and highways to facilitate the movement of raw materials and finished goods. Examples include Nagpur (Maharashtra) and Visakhapatnam (Andhra Pradesh).
  - **Ports:** Seafood processing plants cluster around ports like Mangalore (Karnataka) and Visakhapatnam, enabling easy export access.
- **Government Incentives:**
  - "One District, One Product" scheme: This initiative encourages establishing processing units in specific districts based on their unique agricultural produce, offering subsidies and infrastructure support.
  - Tax breaks and grants: States like Andhra Pradesh and Telangana offer tax breaks and grants to attract food processing investment.

- **Regulations:**
  - Food parks: Mega Food Parks provide streamlined regulatory clearances and infrastructure, attracting companies seeking efficient compliance.
  - Special Economic Zones (SEZs): SEZs like Kakinada SEZ (Andhra Pradesh) offer relaxed regulations and duty benefits, attracting food processing units focusing on exports.
- **Other Factors:**
  - **Availability of Utilities:** Industrial corridors like the Delhi-Mumbai Industrial Corridor attract processing units with reliable power and water supplies.
  - **Cost of Land:** States like Madhya Pradesh offer comparatively cheaper land, attracting budget-conscious processing units.
  - **Quality of Life:** Hill stations like Darjeeling (West Bengal) attract tea processing units due to the suitable climate and good quality of life for skilled workers.

Food Processing Industries: India

- The Indian food processing industry is a significant contributor to the nation's growth, production, consumption, and exports.
- It produces various food products including meat, poultry, fisheries, fruits, vegetables, spices, milk, alcoholic beverages, plantations, grains, cocoa products, chocolates, confectionery, mineral water, soy-based items, and high-protein foods.
- Since the liberalization in 1991, the government has implemented various projects to encourage growth and investment in the industry.
- The FDI equity inflow in the Food Processing Sector for FY 2023 was $0.896 Bn. India's food processing sector is a **sunrise sector** that has gained prominence in recent years, exporting processed products such as fruits, juices, pulses, guar gum, groundnuts, milled products, cereals, oil meals, and alcoholic beverages. Agri and processed food exports reached US$ 26.3 billion in 2022-23.

Steps Taken

- **Pradhan Mantri Kisan SAMPADA Yojana (PMKSY):** This scheme aims to create integrated cold chain and value addition infrastructure, expand food processing and preservation capacities, develop agro-processing clusters, and support backward and forward linkages for farmers and entrepreneurs.
- **Pradhan Mantri Formalization of Micro Food Processing Enterprises (PMFME) Scheme:** This scheme provides financial, technical, and business support to upgrade existing micro food processing enterprises and promote innovative and organic products. It also supports SHGs, FPOs, cooperatives, and individual micro enterprises.
- **Production Linked Incentive (PLI) Scheme for the Food Processing Industry:** This scheme offers incentives to large and small enterprises based on their sales and investment criteria, as well as branding and marketing activities abroad. The scheme aims to create global food manufacturing champions, promote Indian brands, increase employment opportunities, and ensure remunerative prices for farm produce.

HEAVY ENGINEERING INDUSTRIES

Automobile Industry: World

- The automobile industry is one of the most influential and dynamic sectors of the global economy, affecting the lives of billions of people and generating trillions of dollars in revenue.
- It encompasses a wide range of activities, from the design and development of vehicles, to their manufacturing, marketing, selling, repairing, and modification. It also involves various stakeholders, such as automakers, suppliers, dealers, consumers, regulators, and policymakers.
- The history of the automobile industry dates back to the 19th century, when pioneers such as Karl Benz, Gottlieb Daimler, and Henry Ford invented and popularized the use of motor vehicles. Since then, the industry has undergone several transformations, driven by technological innovations, market trends, consumer preferences, environmental concerns, and competitive forces.
- Some of the major milestones in the evolution of the industry include the mass production of affordable cars, the emergence of global markets and brands, the development of alternative fuels and electric vehicles, and the advent of autonomous and connected vehicles.

Some of the key regions that have thrived in this sector are:

- **Detroit, Michigan, USA:** Detroit is often referred to as the "Motor City" and has been a historical centre for the American automobile industry. It is home to major automakers such as Ford, General Motors, and Stellantis (formerly Fiat Chrysler).
- **Tokyo, Japan:**Tokyo and its surrounding areas are significant hubs for the global automotive industry, with major Japanese automakers like Toyota, Honda, Nissan, and Subaru headquartered in the region.
- **Stuttgart, Germany:** Stuttgart is a key centre for the German automotive industry, particularly known for luxury and performance vehicles. Companies like Mercedes-Benz and Porsche have their headquarters in this region.
- **Seoul, South Korea:** South Korea, with Seoul as a focal point, has become a major hub for the automobile industry, with companies like Hyundai and Kia making significant contributions.
- **Shanghai, China:** China, with Shanghai as a central hub, has rapidly emerged as a major player in the global automotive industry. Chinese automakers like BYD, Geely, and NIO have gained prominence.

Global Automobile Industrial Regions:

Asia:

- **China:** By far the world's largest producer of automobiles, China Produces a Record 30 Million Cars. This dominance is driven by a massive domestic market, a strong government push for electric vehicles, and the presence of several major domestic and international automakers.

Fig. 9.13: Major Automobile hubs

- **Japan:** Though no longer the global leader, Japan remains a powerhouse in the industry, known for its advanced technology and quality vehicles. Major Japanese automakers include Toyota, Honda, and Nissan.
- **India:** The fastest-growing major automobile market globally, In financial year 2023, the total production volume of vehicles in India was around 25.93 million units Production volume of vehicles India FY 2011-2023, by segment - Statista and is expected to see continued growth in the coming years. Although two-wheeler manufacture dominates the market, the production of passenger cars is also increasing.
- **Other notable players:** South Korea, Thailand, Indonesia, and Malaysia also have significant automobile industries, catering to both domestic and export markets.
- **North America:**
- **United States:** The second-largest automobile producer in the world, the US manufactured over 10 million vehicles in 2022. The industry is home to major automakers like General Motors, Ford, and Stellantis (formerly Fiat Chrysler Automobiles).
- **Mexico:** A growing player in the industry, Mexico has attracted significant investment from major automakers due to its low labour costs and proximity to the US market.
- **Europe:**
- **Germany:** A leader in luxury car production, Germany is home to renowned brands like Audi, BMW, and Mercedes-Benz. The country also has a strong presence in commercial vehicle production.
- **Other notable players:** France, Italy, Spain, and the United Kingdom also have significant automobile industries, with a mix of established and emerging players.
- **Other regions:**
- **South America:** Brazil is the largest automobile producer in South America, followed by Argentina and Colombia. The industry is facing challenges due to the economic instability in the region.
- **Africa:** Despite a growing market, Africa's automobile industry is still relatively small. South Africa is the continent's largest producer, followed by Egypt and Morocco.

Automobile Industry: India

- At the time of independence, India didn't have a domestic automobile manufacturing industry. Instead, imported automobile parts were used for assembly. Companies like General Motors and Ford were among the first multinational companies to set up assembly plants in India.
- Post-Independence, the Indian government encouraged the development of a domestic automobile industry. Premier Automobiles Ltd. (established in Kurla, Mumbai, in 1947) and Hindustan Motors Ltd. (established in Uttarpara, Kolkata, in 1948) played crucial roles in the industry's growth.
- Significant changes occurred in the Indian automobile industry after the economic liberalization in 1991. As a result of liberalization, India saw a diverse range of automobile manufacturers entering the market.
- The automobile industry is divided into four segments: two-wheelers, three-wheelers, passenger vehicles, and commercial vehicles. The percentage of national GDP contributed by this sector has climbed from 2.77% in 1992-1993 to roughly 7.1% now. It directly and indirectly employs over 19 million people. By 2026, the Indian automobile sector is anticipated to be worth $300 billion.

Locational Factors for Automobile Industry

- **Access to Natural Resources:** Abundant natural resources, like iron and coal deposits, can provide a significant advantage for regions engaging in automobile manufacturing, which relies heavily on raw materials such as steel and aluminum.
- **Skilled Labour Force:** The technical nature of the automobile industry necessitates a skilled workforce. Regions with robust engineering and technical education programs are more likely to foster the development of a skilled labour force for the industry.

- **Government Policies and Incentives:** Government policies and incentives, such as subsidies for research and development or tax breaks for industry investments, can significantly influence the growth of the automobile sector.
- **Access to Markets:** Given the globalized nature of the automobile industry, having access to large domestic and international markets is crucial for its success.
- **Infrastructure:** Efficient infrastructure, including well-developed highways, ports, and airports, is essential for the smooth movement of goods and people within the automobile industry.
- **Cheap Land Availability:** Industries such as automobile manufacturing require substantial land for assembly lines, administrative buildings, and testing facilities.
- **Cheap Skilled Labour:** Given the capital-intensive nature of these industries, the preference for regions with readily available and affordable skilled labour is evident. Government initiatives for ongoing skill development in an area are also desirable.
- **Industrial Conglomeration:** The development of supporting infrastructure over time in an area where an industry is already established makes it advantageous for new industrial proposals to set up plants in the same region.
- **Closeness to the Final Customer:** Proximity to the final customer is preferred for better service and reduced transportation costs, allowing manufacturers to adapt to changing customer preferences effectively.
- **Closeness of suppliers- OEM Interaction Crucial for the Automobile Industry**: Maintaining proximity to Original Equipment Manufacturers (OEMs) for components like window glass, seats, wipers, and tyres is crucial to prevent input cost increases and ensure competitiveness. Examples include clusters like Manesar and Gurgaon in India.

Fig. 9.14: Metal Industries in India

- **National Policy on Biofuels (2022):** Objective of mixing **20% ethanol into fuel** and **5% biodiesel into diesel** by 2025-26.

Government Initiatives in the Indian Automobile Industry

- **PLI Plan:** Proposed PLI plan for autos and auto components totaling **Rs. 25,938 crore (US$ 3.49 billion)**. Estimated to attract about **Rs. 42,500 crore (US$ 5.74 billion)** in investments by 2026.
- **FAME-II Modification:** Modification of the **FAME-II plan** to boost the usage of electric two-wheelers in India.
- **Flex-Fuel Engines:** The intention is to make it mandatory for manufacturers to create **flex-fuel engines** with the necessary permits.

The Way Forward

- **Crucial Elements:** Stable policies, infrastructure development, financial incentives for EVs, and skilling initiatives.
- **Embracing Digital Technologies:** Utilize **digital technologies** for efficient production, supply chain management, and an enhanced customer experience.
- **Strategic Partnerships:** Collabourate with industry leaders for targeted skilling programs focused on **advanced manufacturing, AI, and EV technologies**.
- **Investment in R&D:** It is essential to invest in research and development for **EVs, alternative fuels, and connected technologies**.

Ship Building Industry: World

- The world shipbuilding industry is the sector that constructs and repairs ships and other floating vessels. It is a strategic and important industry for global trade, transportation, and defense.
- According to a report by Mordor Intelligence, the world shipbuilding market size was estimated at USD 145.67 billion in 2023 and is expected to reach USD 184.50 billion by 2029, registering a CAGR of 4.84%.
- The report also states that the East Asian region dominates shipbuilding, with China, Japan, and South Korea being the largest shipbuilding nations in the world.
  - China alone received 49% of all shipbuilding orders in 2022, making it a global shipbuilding powerhouse.
- Southeast Asia is also concentrated in ship demolition, with Bangladesh, India, and Pakistan accounting for nearly 90% of global ship scrapping activities.

NOTABLE SHIPBUILDING & SHIP REPAIR YARDS

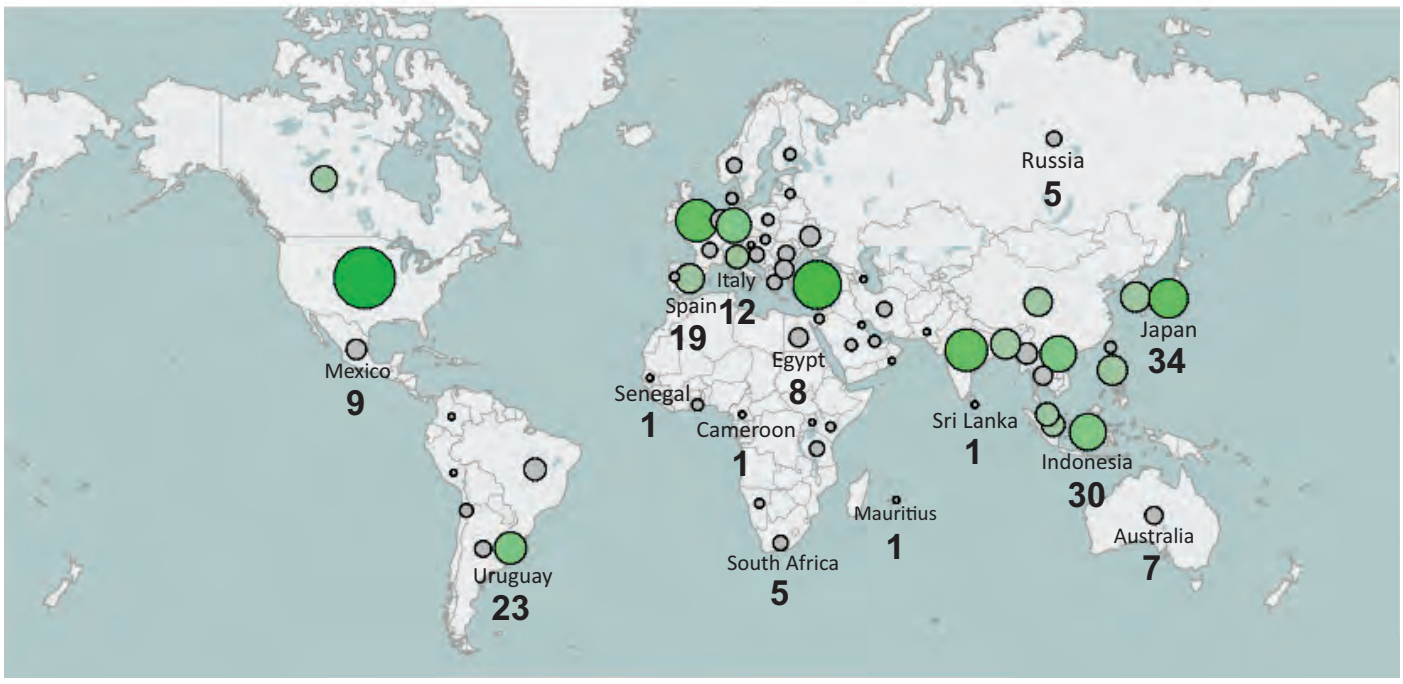


Fig. 9.15: Shipbuilding and Ship Repair Yards around the world

Ship Building Industry: India

- According to the Ministry of Shipping, sea transport accounts for approximately 95% of India's commerce by volume and 70% by value. India has 12 major ports and around 200 designated small and intermediate ports.
- The National Perspective Plan for Sagarmala includes the construction of six new mega ports in the country.
  - The Indian ports and shipping sector are critical to supporting the country's trade and commerce growth.
- With a coastline of 7,516.6 km, India is the world's sixteenth-largest marine country. The Indian government is a major supporter of the port industry.
  - It has permitted up to 100% FDI through the automatic route for port and harbour building and maintenance projects.
  - It has also made a 10-year tax break available to businesses that construct, manage, and operate ports, inland waterways, and inland ports.

Locational Factors for Ship Building Industry

- **Access to raw materials:** Shipbuilding requires a lot of steel, wood, and other materials. Shipyards are often located near sources of these materials to reduce transportation costs.
  - For example, many shipyards in South Korea are located near steel mills.
- **Deepwater access:** Ships need deep water to launch and be operational. Shipyards are therefore often located on coasts or rivers with deepwater access.
  - For example, the port of Rotterdam in the Netherlands is one of the busiest in the world because of its deepwater access.
- **Skilled labour:** Shipbuilding is a complex and skilled trade. Shipyards need to be located near populations of skilled workers, such as welders, pipefitters, and electricians.
  - This is why many shipyards are located in countries with large industrial workforces, such as China and India.

- **Government support:** Many governments provide subsidies and other forms of support to the shipbuilding industry. This can make it more attractive for shipyards to locate in certain countries.
  - For example, the South Korean government has provided billions of dollars in subsidies to the shipbuilding industry in recent years.
- **Market access:** Shipyards need to be located near their target markets. For example, shipyards that build container ships are often located near major shipping lanes.
  - This is why many shipyards are located in Asia, which is home to a large and growing market for container ships.
- **Environmental regulations:** Environmental regulations can also influence the location of the shipbuilding industry. For example, some countries have stricter regulations on air and water pollution than others. This can make it more expensive to build ships in some countries.
- **Infrastructure:** Shipyards need access to good infrastructure, such as roads, railways, and airports. This is so that they can transport materials and workers to and from the shipyard.

Fig. 9.16: Heavy Engineering Industries in India

Aircraft Manufacturing Industry: World

- The world aircraft manufacturing industry is the sector that produces airplanes and their components for various purposes, such as commercial, military, and private use.
- According to a report by Polaris Market Research, the global aircraft manufacturing market was valued at USD 413.51 billion in 2021 and is expected to grow at a CAGR of 3.7% by 2030.
- The top country where the aircraft manufacturing industry is located is the United States of America, followed by France, Germany, United Kingdom, and Canada. These five countries accounted for about 75.5% of the global aerospace exports in 2022.
- Some of the leading aerospace and defense manufacturers in these countries are Boeing, Airbus, Lockheed Martin, Raytheon Technologies, Bombardier, and others.

Aircraft Manufacturing Industry: India

- The aircraft manufacturing industry in India is experiencing significant growth, with increasing private sector participation and collabourations with international aircraft manufacturers.
- It encompasses both commercial and defence aircraft production, with notable contributions from companies like Hindustan Aeronautics Limited (HAL). India is also investing in aerospace research and development and has a skilled workforce.
- The industry is also tackling challenges which include regulatory hurdles and infrastructure limitations, but India's aerospace sector is becoming a global hub for manufacturing components, catering to both domestic

and international markets.

- Recently India inaugurated its C-295 aeroplanes manufacturing facility which will be the nation's first privately owned facility for the production of aeroplanes. The facility will be an important step in releasing Atma Nirbharta in the defence industry and will also assist in maximising the potential of private companies.

Locational Factors for Aircraft Manufacturing Industry

- **Market**: The demand for aircrafts in different regions and countries influences the location of production facilities. For example, the US and China are the largest markets for commercial aircrafts, and hence have many aircraft manufacturers based there.
- **Materials Supply**: The availability and cost of raw materials, such as metals, composites, electronics, etc., affect the location of aircraft manufacturing. For example, India has an abundant supply of aluminum, which is used for making aircraft frames.
- **Transportation**: The ease and cost of transporting the finished products, as well as the raw materials and components, influence the location of aircraft manufacturing. For example, coastal areas or regions with good rail and road connectivity are preferred for aircraft manufacturing.
- **Power**: The availability and cost of power, such as electricity, fuel, etc., affect the location of aircraft manufacturing. For example, countries with abundant and cheap sources of power, such as Russia and Norway, have an advantage in aircraft manufacturing.
- **Government Policies**: The strategic and political interests of the government, as well as the regulations and standards, affect the location of aircraft manufacturing. For example, countries with strong defense and aerospace sectors, such as the UK and Israel, have supported the development of aircraft manufacturing.

Railway Equipment Industry: World

- The railway equipment industry is the sector that deals with the manufacture, sale, and operation of railway technology, such as rolling stock, infrastructure, components, and others.
- The railway equipment industry is a vital part of the global transportation system, as it provides efficient, safe, and environmentally friendly solutions for passenger and freight transport.
- According to a report by Knowledge Sourcing, the global railway equipment market size was valued at US$ 59.623 billion in 2022 and is expected to grow at a compound annual growth rate (CAGR) of 4.02% to reach a market size of US$ 72.461 billion by 2027.
- Some of the key factors driving the market growth are the increasing demand for urban mobility, the growing investments in railway infrastructure development and modernization, the rising adoption of high-speed trains and electrified rail systems, and the emergence of smart and digital technologies in the railway sector.
- Some of the major players in the global railway equipment market are China, the U.S., Germany and Japan.

Railway Equipment Industry: India

- The Indian railway equipment market is expected to experience significant growth due to the increasing volume of transported products and the distance covered by logistics vehicles.
- Key players operating in the railway equipment manufacturing industry are involved in the manufacturing of brakes, locomotives, passenger rail cars, freight, and other railway equipment parts.
- The market is further categorized into rolling stock and railway infrastructure. Among these, the need for rolling stock is rapidly rising in the Indian market for railway equipment.
- The market is also segmented into locomotives, DMUs, EMUs, freight vehicles, and others.Key market players include Nokia Corporation, Kawasaki Heavy Industries, Toshiba India Pvt. Ltd., Hitachi India Pvt. Ltd., Siemens, General Electric, Hyundai Rotem, Alstom, Bombardier Transportation India Pvt Ltd, and Metalocaucho MTC (Wabtec company).

Locational Factors for Railway Equipments Industry

- **Proximity to Raw Materials:** Railway equipment factories locate near sources of steel, iron, and metals to cut transportation costs; e.g., Pennsylvania hosts both steel mills and railway equipment manufacturers.
- **Proximity to Markets:** Being close to customers is crucial for bulky items like locomotives; China's railway equipment manufacturing is concentrated due to its large domestic market.
- **Availability of Skilled Labour:** Specialized skills like welding and machining are essential; Siemens' locomotive plant in Munich benefits from the city's engineering history.
- **Government Policies:** Governments influence industry locations with subsidies; India attracts railway equipment manufacturers through incentives.
- **Infrastructure:** Efficient transportation infrastructure is vital; manufacturers prefer areas with well-developed ports, railways, and highways.
- **Other Factors:** Land availability, energy costs, and environmental regulations also impact the location of the railway equipment industry.

FOREST-BASED INDUSTRY

Forest-based industry is a term that encompasses various economic activities that rely on forest resources as raw materials or inputs. Forest-based industry includes sectors such as woodworking, furniture, pulp and paper, match, silk, lac, sports goods, handicrafts, and bioenergy. Forest-based industry plays an important role in the development of many countries, especially in rural areas, by providing employment, income, and foreign exchange. Forest-based industry also contributes to environmental sustainability by promoting forest management, conservation, and restoration.

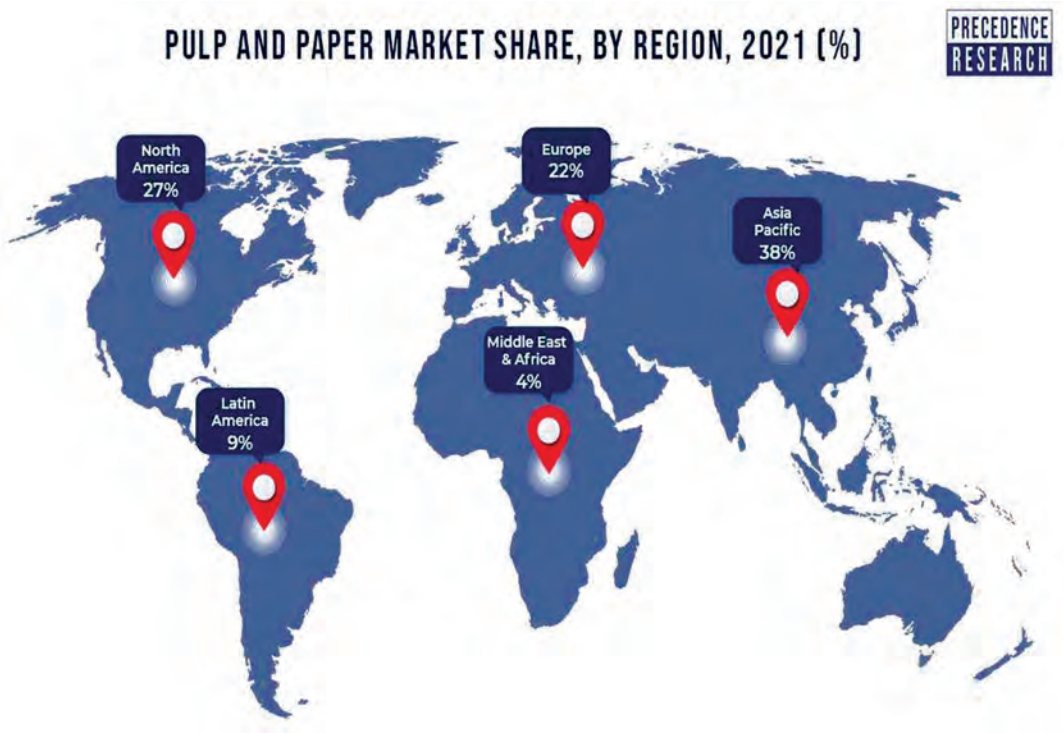


Fig. 9.17: Pulp and Paper Industry in the world

Paper Industry: World

The paper industry is a global sector that produces various types of paper and paper products, such as packaging, printing, writing, tissue, and specialty paper. The paper industry is also involved in the production of pulp, which is the raw material for paper. The paper industry is influenced by factors such as demand, supply, prices, environmental regulations, technological innovations, and trade policies.

The largest paper producing countries in the world are **China and the United States, followed by Japan, Germany, and India.** The market is projected to register a compound annual growth rate (CAGR) of 0.72 percent from 2022 to 2029 to reach a value of roughly 373 billion U.S. dollars.

Global Distribution of Paper Industry

- **Asia:** Dominates global production. China is the undisputed leader, producing nearly a third of the world's paper, followed by Japan, India, and Indonesia.
  - This dominance is attributed to factors like large domestic markets, readily available raw materials like bamboo, and government support.
- **North America:** The United States and Canada have traditionally been major producers, but their output has declined in recent years due to factors like digitalization and increased environmental concerns. The US still ranks second globally, but with a significant gap behind China.
- **Europe:** Historically a major producer, Europe's paper industry has also shrunk in recent decades. However, countries like Finland, Sweden, and Germany remain significant players, known for their focus on high-quality, specialty paper grades.
- **Other regions:** Brazil, Russia, and South Africa also have notable paper industries, driven by factors like large domestic markets and abundant natural resources.

Paper Industry: India

- The Indian paper sector **accounts for around 5% of global paper output.** The industry's anticipated turnover is around INR 80,000 crore, with a contribution to the exchequer of roughly INR 5,000 crore.
- The industry **employs 500,000 people directly and another 1.5 million indirectly.** Because most paper mills have been in operation for a long time, contemporary technologies range from the oldest to the most modern.
- The mills utilise a range of raw materials, including wood, bamboo, recycled fibre, bagasse, wheat straw, rice husk, and so on. In terms of total production, about 21% is based on wood, 71% on recycled fibre, and 8% on agro-residues.
- The global distribution of the industry and market is primarily responsible for the regional balance of production and consumption.India's per capita paper usage, at roughly 15 kilogrammes, is much below the global average of 57 kg.

- **India is the world's fastest-growing paper market**, presenting an exciting scenario in which paper consumption is poised to take a significant leap ahead in tandem with economic expansion. According to the forecast, growth in paper consumption will be measured in multiples of GDP, therefore an increase in consumption of one kilogramme per capita would result in an increase in demand of one million tonnes.

Locational factors for Paper Industry

- **Raw Material:** To minimize the challenges of transporting bulk logs and reduce costs, pulp mills are strategically positioned near forests. An ideal site is along a riverbank, allowing logs to be floated directly to the mill.
  - A robust forest with ample softwoods like Spruce, Cedar, Hemlock, Deodar, Eucalyptus, etc., is vital for the paper industry. Pulp manufacturing units strategically located near these forests ensure a steady and convenient wood supply.
- **Water** : The paper industry needs a significant amount of water, approximately 100 tons per ton of newsprint. To sustain production, abundant chemical-free, fresh water is crucial. Such conditions are often found in sparsely populated, forested regions rather than major industrial complexes.

Fig. 9.18: India: Forest-Based Industry

- **Power**: Producing a ton of newsprint requires around 2,000 kilowatt-hours of electricity, making access to abundant and affordable power crucial for paper plants. In Canada, rivers are commonly utilized to provide hydroelectric power to pulp mills.
  - Hydropower in the southern United States has spurred the creation of major pulp mills, among the world's largest. Without hydroelectricity, these mills are typically located close to traditional power plants.
- **Transport**: Newsprint and paper transport costs are slightly higher than raw material, but processing reduces weight. Paper mills are often near coasts, leveraging rivers for log transport to the sea.
  - Coastal mills in Sweden and Britain strategically position themselves for efficient paper and pulp export, utilizing the convenience of loading onto ships.
- **Capital**: The paper industry demands substantial capital, primarily for advanced machinery. Initial investments correlate with mill size, with larger mills, often tied to printing and publishing, requiring higher funding, and some may even own their own forests.
- **Labour**: In contemporary times, paper mills are extensively mechanized, resulting in a reduced requirement for manpower. This characteristic allows them to be situated in remote regions where there is a shortage of labour.

Problems of Paper Industry

- **High Cost of Production:** The international prices of capital equipment required for the paper industry remain notably high. Over the last decade, the costs of power and coal have surged. Simultaneously, royalties on bamboo and hardwood have risen by 70%, and the industry grapples with heavy transport costs due to the bulkiness of raw materials.
- **Problems of Royalties and Lease:** Governments increasing royalties on forest land leased to paper mills for meeting current expenditures pose challenges. In

some states, royalty rates have escalated 5-6 times within a short 5 to 6 years. Such fluctuating policies regarding royalties and lease terms are unsatisfactory, emphasizing the need for stable, long-term policies.

- **Overcapacity and Underutilization:** Government encouragement has led to overcapacity in the industry. The establishment of 180 mills between 1974 and 1984 created excess capacity, even though recent years have seen a high capacity utilization rate of 72%.
- **Non-availability of Coal and Raw Materials:** The non-availability of coal and raw materials, coupled with rising electricity and water charges, hinders the growth of small paper units. Consequently, they struggle to compete with larger counterparts.
- **Average Size of Paper Mills:** The average size of paper mills in India is abnormally low, at less than 10,000 tonnes, compared to 50,000 tonnes in Southeast Asia and 85,000 tonnes in the Asia-Pacific region.

Way Forward

- Invest in innovation and technology to improve the quality, efficiency, and sustainability of paper production and products.
- Expand product portfolio into growing markets like packaging, tissue, and specialty paper to capitalize on industry strengths in printing and writing paper..
- Enhance the competitiveness and profitability of the industry by optimizing the cost structure, increasing the scale and consolidation, and strengthening the value chain.

Rubber Industry: World

The rubber industry is a global sector that produces and consumes natural and synthetic rubber. Rubber is widely used in various products, such as tires, footwear, industrial goods, and medical devices. The rubber market size is projected to reach USD 51.21 billion by 2027. The rubber industry is influenced by factors such as the demand and supply of rubber, the price of crude oil, the environmental regulations, and the technological innovations. Some of the major producers and consumers of rubber are China, India, Indonesia, Thailand, and the United States.

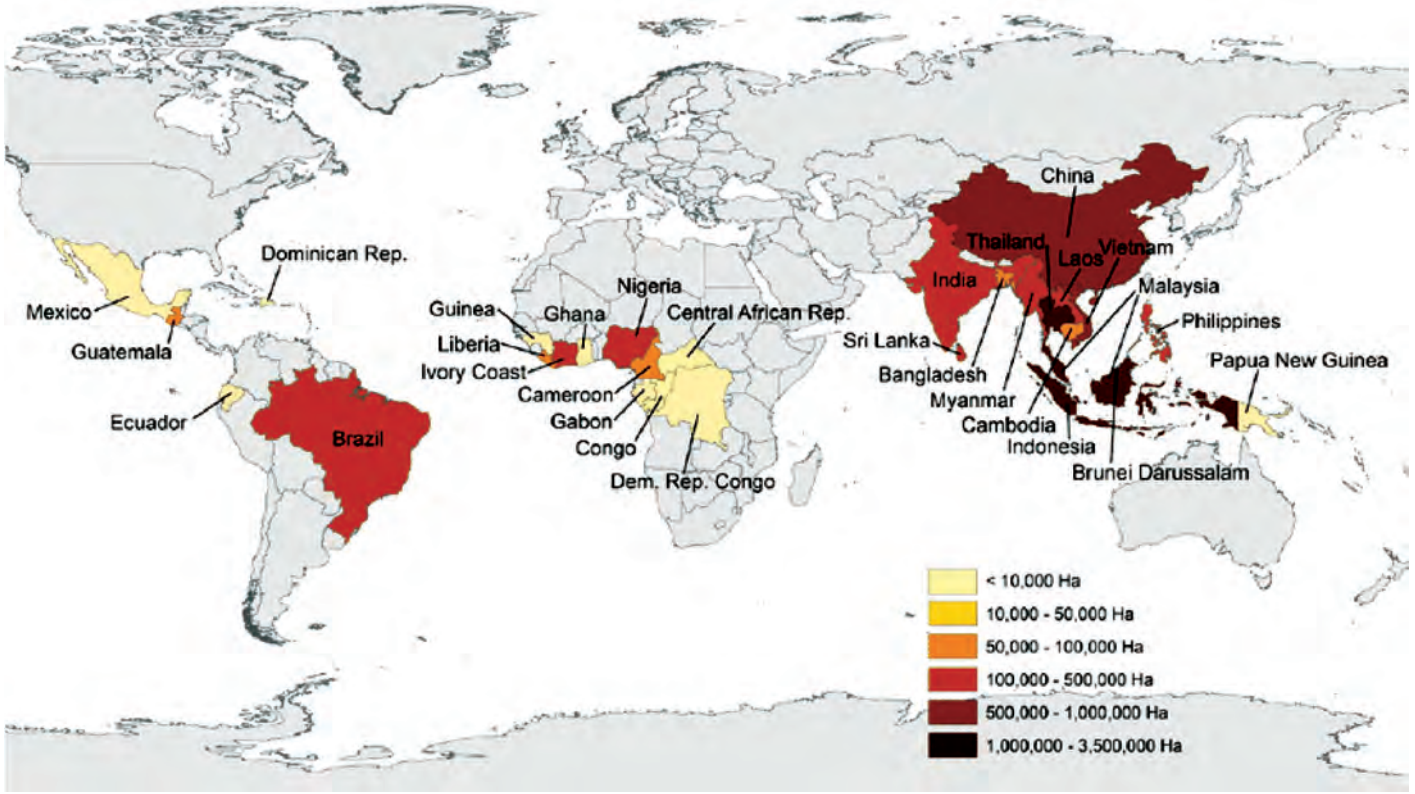


Fig. 9.19: Rubber Industry - World

The global rubber industry is spread across various regions in

- **Southeast Asia:** This region accounts for the majority of natural rubber production, with Thailand, Indonesia, Malaysia, and Vietnam being the top producers. These countries benefit from a favorable tropical climate ideal for growing rubber trees.
- **Africa**: While production is lower than in Southeast Asia, countries like Ivory Coast, Nigeria, and Liberia are significant players in natural rubber production.
- **South America:** Brazil is the main producer in this region, followed by countries like Thailand and Ecuador.
- **Other regions:** Smaller amounts of natural rubber are also produced in India, China, and Central America.

- **Distribution of Synthetic Rubber:** Synthetic rubber production is more geographically diverse, with major manufacturing facilities located in:
- **North America:** The United States is a major producer of synthetic rubber.
- **Europe:** Germany, France, and Italy have significant synthetic rubber production.
- **Asia:** China, Japan, and India are also major producers.
- **Other regions:** Synthetic rubber is also produced in South America and Africa, but to a lesser extent.

Factors affecting location of Rubber Industry

- **Raw Material Access:**
  - **Availability of Rubber Trees:** This is crucial for natural rubber production. Countries like Thailand, Indonesia, and Malaysia thrive due to their vast rubber plantations.
  - **Synthetic Rubber Alternatives:** Access to technology and petroleum resources enable synthetic rubber production. For instance, the US rubber industry benefited from readily available petroleum during World War II, boosting synthetic rubber development.
- **Climate and Geography:**
  - **Favorable Growing Conditions:** Rubber trees require specific temperature, rainfall, and soil conditions. The Amazon rainforest's unsuitable climate hinders large-scale rubber plantations in South America.
- **Technological Advancement:**
  - **Processing Techniques:** Efficient latex extraction, processing, and vulcanization methods are crucial. Charles Goodyear's vulcanization process revolutionized the industry by improving rubber's strength and durability.
- **Economic and Political Factors:**
  - **Government Policies:** Supportive policies like subsidies, infrastructure development, and research funding can boost the industry. Malaysia's government investments in rubber research and development have strengthened its position.
  - **Market Demand:** Robust demand for rubber products like tires, hoses, and medical equipment drives industry growth. China's rapid automobile market expansion has fueled its demand for rubber.

Major environmental issues faced by rubber producing countries

- **Deforestation:** Large-scale conversion of natural forests into rubber plantations by the rubber industry has resulted in biodiversity loss and habitat destruction, leading to the decline of various species' populations. For example, **Brazil** has experienced significant deforestation due to rubber cultivation.
- **Soil degradation**: Extensive rubber tree cultivation has caused soil degradation, diminishing soil fertility and productivity. Additionally, the widespread use of pesticides, herbicides, and fertilisers has contaminated soil and water resources, as seen in Venezuela.
- **Water pollution:** The rubber industry's irrigation demands contribute to water resource depletion and water pollution due to agrochemical runoff into water bodies. This issue is prominent in countries like **Peru**.
- **Climate change:** The rubber industry's activities, including deforestation, land-use changes, and fossil fuel use for transportation, release greenhouse gases, exacerbating climate change. Brazil is a notable example where the rubber industry has contributed to climate change.
- **Labour and human rights issues:** Labour and human rights violations are associated with the rubber industry, including worker exploitation, child labour, and land grabbing from indigenous communities.

Rubber Industry: India

India's rubber sector is poised to surpass the US as the world's second-largest player in the industry. **India is third largest producer.** It is mainly grown in Kerala, Tamil Nadu, Karnataka and Andaman and Nicobar islands,, although production is expanding in North-East India as well. Both natural rubber and synthetic rubber work together to provide the appropriate finished rubber goods.

In India, synthetic rubber accounts for around 30% of total rubber use, whereas the global average is 65%. As a result, the Indian government supports the building and growth of synthetic rubber facilities.

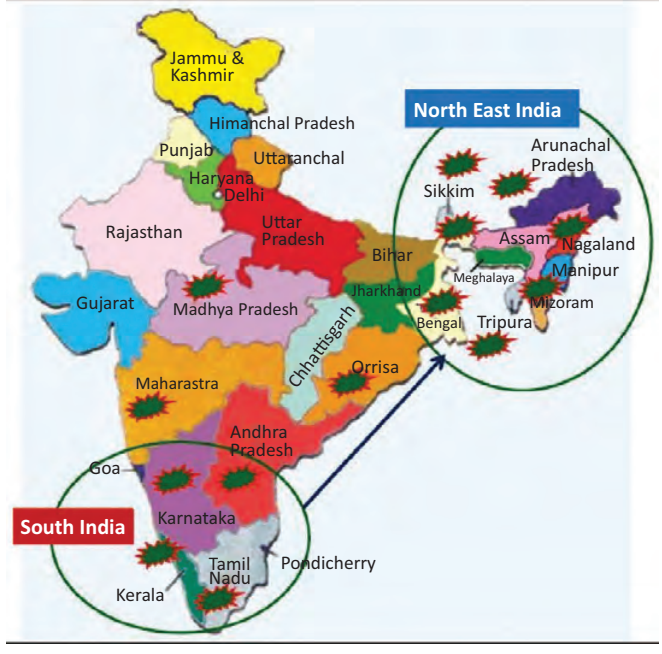


Fig.9.20: Rubber production in India

Challenges of Rubber Industry

- **Decrease in Rubber Productivity:** The significant decrease in rubber productivity per hectare indicates that rubber growers are facing difficulties in maintaining and increasing their rubber output, which can impact the overall supply of natural rubber in the country.
- **Declining Natural Rubber Prices**: The consistent drop in natural rubber prices has made it less profitable for

rubber growers. This, combined with high labour costs, has discouraged many small and marginal farmers (representing 75 per cent of rubber growers) from tapping rubber trees, leading to reduced production.

- **Competing Interests between Growers and Tyre Companies:** There is a conflict of interest between rubber growers and tire companies. Large tire firms have been importing rubber, reducing domestic demand for locally produced rubber.
- **Unusual Duty System and Inexpensive Imports:** An unusual duty system and inexpensive imports imply that government policies and trade practices may not be providing adequate protection or support to domestic rubber growers. Cheaper imports can negatively affect domestic prices.

Government Initiatives

India has implemented several initiatives and policies to support its rubber industry such as:

- **Plantation Scheme:** The government has launched the **Rubber Plantation Development Scheme** and **Rubber Group Planting Scheme** to encourage the cultivation of rubber.
- **Investment:** Allowed **100% Foreign Direct Investment (FDI)** in rubber production industries, attracting foreign investment and expertise.
- **Policy Initiative:** The launch of the **National Rubber Policy, in 2019,** outlines strategies to boost the natural rubber sector's sustainability and competitiveness.
- **Administrative Initiative:** A dedicated Rubber Board to oversee the proper implementation of the schemes, and to ensure quality standards and conduct research and development.

Way Forward

- Develop dedicated rubber clusters and industrial parks with better roads, storage facilities, and processing units.
- Encourage rubber growers to form cooperatives to improve bargaining power and negotiate better prices for their produce.
- Promote adoption of sustainability certifications like Fairtrade or Global G.A.P. to meet international buyer demands and improve brand reputation.

MINERAL-BASED INDUSTRIES

Iron and Steel: World

The iron and steel industry is one of the most important industries in the world, as it produces the raw material for many other sectors, such as construction, transportation, machinery, and defense. The iron and steel industry is also a major source of employment, income, and trade for many countries.

- The global iron and steel market was valued at USD 1,599.4 billion in 2022 and is projected to reach USD 1,928.6 billion by 2027.
- China is the world's leading producer of iron and steel, accounting for over 50% of global production. Other major producers include India, Japan, the United States, and Russia.

Geographical Distribution of Iron and Steel Industries in world

The geographical distribution of iron and steel industries in the world is influenced by various factors, such as the availability of raw materials, energy sources, markets, transport facilities, and government policies.

Some of the major regions and countries that produce and consume iron and steel

- **China: China is the world's largest producer and consumer** of iron and steel, accounting for about 53% of the global crude steel production in 2022. China has abundant reserves of iron ore, coal, and other minerals, as well as a large domestic market and a strong export demand.
  - China's iron and steel industry is mainly concentrated in the eastern and central regions, such as Hebei, Jiangsu, Shandong, Liaoning, and Henan provinces.
- **India: India is the world's second-largest producer and consumer** of iron and steel, with a crude steel production of 12.1 Mt. in 2022. India has rich deposits of iron ore, coal, and manganese, as well as a growing demand for steel from various sectors, such as infrastructure, construction, automobiles, and railways.
  - India's iron and steel industry is mainly located in the eastern and central regions, such as Jharkhand, West Bengal, Odisha, and Chhattisgarh, where most of the major steel plants are situated.
- **Japan: Japan is the world's third-largest producer and consumer** of iron and steel, with a crude steel production of 99.3 million tonnes in 2022. Japan has limited resources of iron ore and coal, and relies heavily on imports from other countries, such as Australia, Brazil, and India.
  - Japan's iron and steel industry is mainly distributed in the coastal areas, such as Hokkaido, Honshu, Kyushu, and Shikoku, where there are good port facilities and access to markets.
- **United States: The United States is the world's fourth-largest producer and consumer** of iron and steel, with a crude steel production of 87.8 million tonnes in 2022.
  - The United States' iron and steel industry is mainly located in the eastern and central regions, such as Pennsylvania, Ohio, Indiana, Illinois, Michigan, and Alabama, where there are rich deposits of coal and iron ore, as well as proximity to the Great Lakes and the Atlantic coast.
- **Other regions and countries:** Some of the other regions and countries that have significant iron and steel industries are Russia, South Korea, Germany, Turkey, Brazil, Iran, Italy, Taiwan, Ukraine, and Vietnam. These countries have varying degrees of availability of raw materials, energy sources, markets, transport facilities, and government policies, which affect their iron and steel production and consumption.

Fig. 9.21: Major Iron and Steel producing countries of the World

Iron and Steel: India

- India is a significant player in the global steel industry. In FY23, it ranked as the second-largest producer of crude steel and finished steel. The sector is expected to grow by 4-7% in FY24. This growth is driven by domestic raw material availability and cost-effective labour.
- The Indian steel industry is modern, with a focus on upgrading and improving energy efficiency in both new and older plants, contributing significantly to the country's manufacturing output.

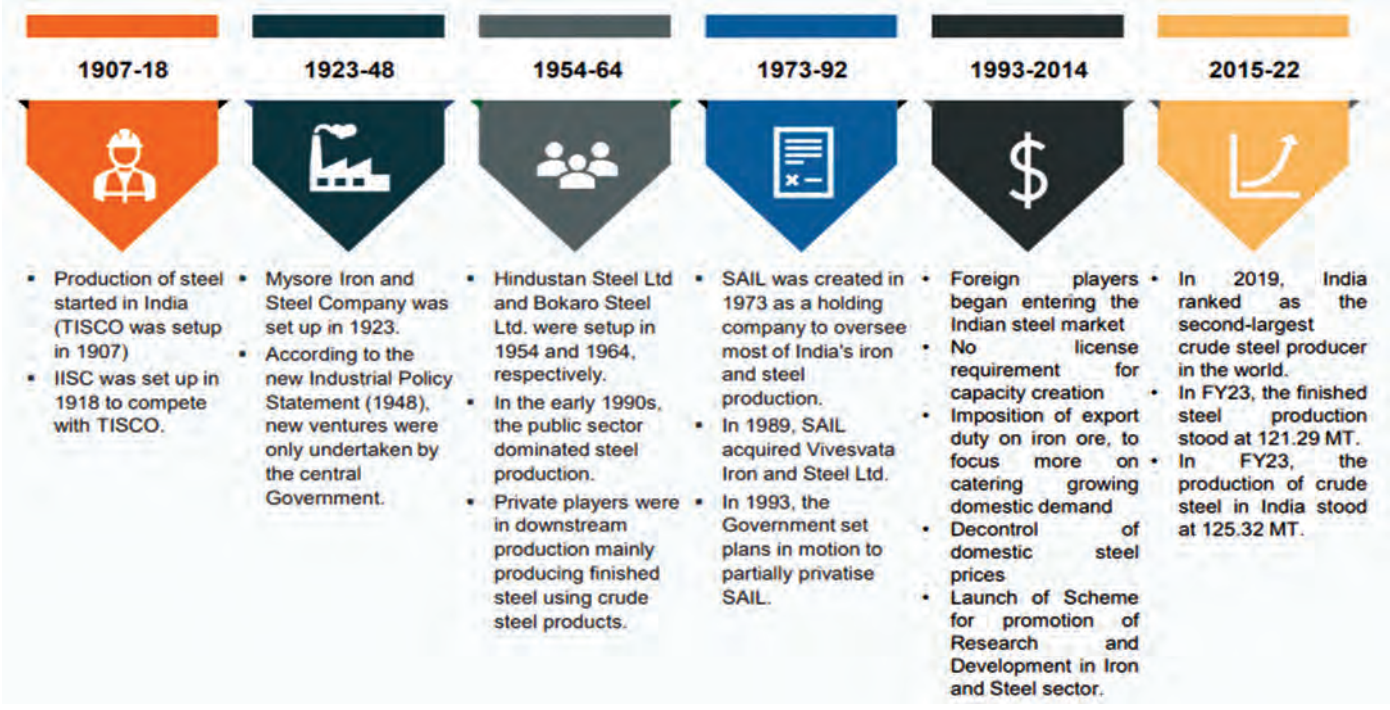

1907-18
• Production of steel started in India (TISCO was setup in 1907)
• IISC was set up in 1918 to compete with TISCO.
1923-48
• Mysore Iron and Steel Company was set up in 1923.
• According to the new Industrial Policy Statement (1948), new ventures were only undertaken by the central Government.
1954-64
• Hindustan Steel Ltd and Bokaro Steel Ltd. were setup in 1954 and 1964, respectively.
• In the early 1990s, the public sector dominated steel production.
• Private players were in downstream production mainly producing finished steel using crude steel products.
1973-92
• SAIL was created in 1973 as a holding company to oversee most of India's iron and steel production.
• In 1989, SAIL acquired Vivesvata Iron and Steel Ltd.
• In 1993, the Government set plans in motion to partially privatise SAIL.
1993-2014
• Foreign players began entering the Indian steel market
• No license requirement for capacity creation
• Imposition of export duty on iron ore, to focus more on catering growing domestic demand
• Decontrol of domestic steel prices
• Launch of Scheme for promotion of Research and Development in Iron and Steel sector.
2015-22
• In 2019, India ranked as the second-largest crude steel producer in the world.
• In FY23, the finished steel production stood at 121.29 MT.
• In FY23, the production of crude steel in India stood at 125.32 MT.

Fig. 9.22: Evolution of Indian Steel Sector

Geographical Distribution of Iron and Steel Industries in India

The geographical distribution of iron and steel industries in India is largely influenced by the availability of raw materials, such as iron ore and coal. Most of the major iron and steel plants are located in the peninsular region, especially in the states of Jharkhand, West Bengal, Odisha, and Chhattisgarh. These states have rich deposits of iron ore and coal, which are essential for steel production.

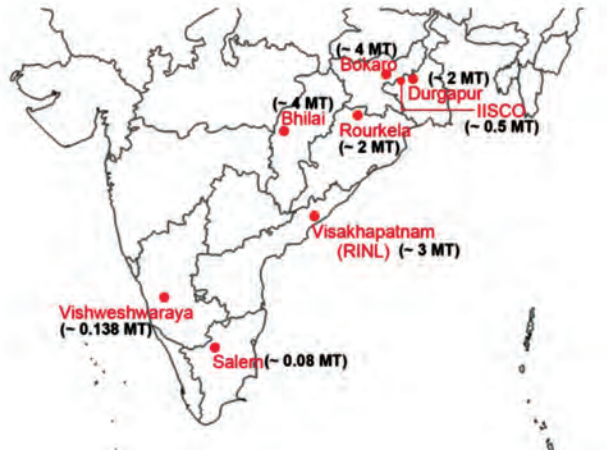


Fig. 9.23: Iron and Steel Plants in India

Some of the important iron and steel plants in India are:

Pre Independence

- **Jamshedpur:** Established by Jamsetji Tata in 1907, it is the first integrated steel plant in India. It is also known as TISCO (Tata Iron and Steel Company). It produces a variety of steel products, such as rails, wires, pipes, and sheets.
- **Burnpur**: Located in West Bengal, it is one of the oldest steel plants in India. It was set up by the British in 1919. It is now part of SAIL (Steel Authority of India Limited). It produces mainly long products, such as bars, rods, and structural items.

Post Independence

- **Durgapur:** Also located in West Bengal, it is another major steel plant under SAIL. It was established in 1959 with the help of the United Kingdom. It produces mainly flat products, such as plates, coils, and strips.
- **Rourkela**: Located in Odisha, it is the first public sector steel plant in India. It was set up in 1955 with the assistance of Germany. It produces both long and flat products, as well as special steels and alloys.
- **Bhilai**: Located in Chhattisgarh, it was set up in 1959 with the collabouration of the Soviet Union. It produces mainly rails, heavy plates, and structurals.
- **Bokaro**: Also located in Chhattisgarh, it is the fourth integrated steel plant under SAIL. It was established in 1964 with the cooperation of the Soviet Union. It produces mainly flat products, such as sheets, coils, and galvanized products.

Some other iron and steel plants in India are:

- **Bhadravati:** Located in Karnataka, it is the oldest steel plant in India. It was started in 1918 as the Mysore Iron Works. It uses locally available charcoal as fuel instead of coal. It produces mainly pig iron and alloy steels.
- **Vijayanagar**: Located in Karnataka, it is the largest private sector steel plant in India. It was set up by JSW Steel in 1994. It uses iron ore from the nearby Bellary-Hospet region. It produces a wide range of steel products, such as hot rolled coils, cold rolled coils, galvanized coils, and wire rods.
- **Salem**: Located in Tamil Nadu, it is the only stainless steel plant in India. It was set up by SAIL in 1982. It uses imported nickel and chrome as raw materials. It produces various grades of stainless steel, such as austenitic, ferritic, and martensitic.

Factors influencing the locations of Iron and steel industries:

- **Raw Material:** Large integrated steel plants are strategically positioned in proximity to the source of raw materials, particularly in regions with abundant quantities of heavy and weight-losing raw materials. For instance, the concentration of the iron and steel industry in the Chota Nagpur region is attributed to the presence of iron ore in this area, exemplified by the TISCO plant in Jamshedpur.
- **Markets:** Given the high transportation costs associated with the heavy and bulky nature of steel, the proximity to markets is crucial. This holds particular significance for mini steel plants, emphasizing the need for access to nearby markets to minimize transportation expenses. Mini steel plants, which primarily rely on scrap metal, are often situated in Maharashtra. Notably, the Visakhapatnam steel plant, located near the coast, benefits from excellent import-export facilities.
- **Labour:** The availability of affordable labour is a key consideration in determining the location of steel plants. Examples include the Rourkela plant in Orissa and the Bhilai steel plant in Chhattisgarh, both predominantly situated in the Chota Nagpur region.
- **Availability of Electricity and Water:** Access to electricity, particularly from hydro sources, and abundant water for cooling are essential factors. The Bokaro steel plant, situated on the banks of the Damodar River, and the Vishveshwaraya steel plant in Kar, near the Bhadra River, exemplify the strategic positioning of steel plants to ensure a reliable supply of electricity and water resources.

Reasons for present location of iron and steel industries away from the source of raw material

- **Transportation**: Transporting raw materials like iron ore and coal from mining regions to manufacturing sites can be costly and inefficient.
  - Therefore, some iron and steel plants are located near major transportation hubs, such as ports, railways, and highways, to optimize logistical efficiency and reduce transportation costs.
  - For example, Tata Steel in Jamshedpur and Bhilai Steel Plant in Chhattisgarh are strategically located near transportation networks.

- **Market**: The demand for iron and steel products is mainly driven by the domestic and export markets.
  - Therefore, some iron and steel plants are located near the major consumption centers, such as urban areas, industrial zones, and coastal regions, to cater to the market demand and minimize distribution costs.
  - For example, the Tata Steel Plant in Jamshedpur is located near the industrial and urban centers of eastern India.
- **Technology**: The advancement of technology, such as electric furnaces and mini steel plants, reduces the dependence on raw materials and enables the use of scrap metal and alternative fuels.
  - For example, the Essar Steel Plant in Gujarat uses natural gas and sponge iron as inputs and produces steel through direct reduced iron (DRI) and electric arc furnace (EAF) processes.
- **Environment**: The iron and steel production process can have significant environmental impacts, such as air pollution, water pollution, and greenhouse gas emissions.
  - Therefore, some iron and steel plants are located away from the densely populated areas, where the environmental regulations are stricter and the public awareness is higher. This helps the plants to mitigate the environmental concerns and ensure compliance with the regulatory standards.
  - For example, the Rourkela Steel Plant in Odisha, which is located in a relatively less populated and forested area, has adopted various measures to reduce its environmental footprint, such as installing pollution control devices, recycling water, and afforestation.
- **Labour:** The availability of skilled and cheap labour is also an important factor for the location of iron and steel plants. Some regions in India have a comparative advantage in terms of the labour supply and quality, which can attract the iron and steel industry to locate there. **For example,** the Bokaro Steel Plant in Jharkhand is located in a region with a high concentration of tribal population, who are skilled in metalworking.

Mini Steels Plants

- A mini steel plant refers to a small-scale facility dedicated to the production of steel. These plants utilize pig iron or scrap iron as their primary raw materials. As secondary units, they rely on steel scrap and sponge iron as raw materials, employing electric and induction furnaces for the processing of these inputs.
- **Location and Purpose of Mini Steel Plants:** Mini steel plants are strategically situated away from integrated plants to cater to local demands. Typically concentrated around urban areas, a significant number of decentralized secondary units engage in the production of steel using steel scrap and sponge iron as raw materials. Electric and induction furnaces are employed in the processing of these raw materials.
- **Product Range and Market Proximity:** Mini steel plants are versatile in their production capabilities, manufacturing mild steel, alloy steel, and stainless steel. Their locations are strategically chosen to be in close proximity to market areas.
- **Norms Liberalization for Efficient Operations:** Recent developments include the liberalization of norms related to minor steel plants, facilitating more efficient operations in this sector.

Merits of Mini Steels

- **Cost-Efficient Establishment:** Mini steel plants boast a lower capital requirement for their establishment compared to larger plants.
- **Shorter Gestation Period:** The production process in mini steel plants is characterized by a shorter gestation period, enhancing their time-efficiency and competitiveness.
- **Operational Flexibility:** Mini steel plants offer greater operational flexibility, given that the raw materials already contain steel content, allowing for more adaptable operations.
- **Decentralised Industrialization Contribution:** These plants play a pivotal role in decentralised industrialization by being established near urban and semi-urban areas with low capital requirements, contributing to balanced regional growth.
- **Local Demand Fulfillment:** Positioned strategically, mini steel plants are adept at meeting local demands swiftly, catering to needs such as utensil setups and steel rods for construction.
- **Contribution to Decentralization of Networks:** Utilizing locally available raw materials, mini steel plants contribute to the decentralization of transportation and distribution networks.

Problems Faced by Mini Steel Plants

- **Capital Requirements:** While the capital needed is less compared to larger plants, it remains a significant hurdle for small entrepreneurs, often necessitating foreign aid for establishment.
- **Technological Lag:** Until the 1960s and 70s, India benefited from advanced Western technology, but the oil crisis led to increased energy costs, impacting plant efficiency. Besides Bokaro and Vizag, most plants suffered due to lower investments in technological advancements.
- **Suboptimal Utilization:** Productivity utilization seldom exceeds 80%, influenced by factors such as strikes, raw material shortages, energy crises, inefficient management, infrastructure bottlenecks, and political influences.
- **Import Dependence:** Increasing demand has led to substantial steel and raw material imports, notably coal from Australia.

- **Low Blast Furnace Productivity:** Disharmony between resource profiles and available technology, exacerbated by the high alumina and unfavorable silica-alumina ratio in Indian iron ore, impacts blast furnace productivity.

Dumping has affected India's domestic steel industry

- **Impact of Increased Low-Priced Steel Imports:** There has been a significant surge in low-priced steel imports in recent times, severely impacting the Indian steel industry.
- **Financial Strain on Domestic Steel Companies:** Domestic steel companies are facing substantial losses, with even large firms experiencing a squeeze on profitability. Complaints regarding this economic challenge have been raised by prominent entities such as SAIL and Essar Steel.
- **Ramifications for the Banking Industry:** The influx of low-priced steel imports has not only adversely affected the steel industry but has also taken a toll on the banking sector. This is evident as a substantial portion of bad loans can be attributed to the challenges faced by the steel industry.

Challenges of Steel Industry

- Industries in India face a range of challenges. One of the prominent challenges is **low productivity,** which hinders economic growth and competitiveness. Furthermore, **the competition from inexpensive imports**, particularly from China and Japan, also undermines local industries by offering cheaper alternatives.
- There is also a **shortage of high-quality coal** for power generation, with the use of lower-quality coal causing environmental problems. **Inadequate access to technology and capital resources** can lead to dependence on foreign investors, potentially impacting a country's economic autonomy.
- Additionally, the passage of time has led to the depletion of raw materials and technological advancements, necessitating shifts in industry locations away from resource-rich areas.

Addressing these challenges requires a comprehensive approach, including investments in education, trade policies, environmental regulations, and strategies for adapting to evolving technology and resource availability.

Government Initiatives

- **Production Linked Incentive Scheme:** The Specialty Steel PLI Scheme, launched in 2021, aims to attract substantial investment and increase speciality steel capacity by 25 million tonnes.
- **Mission Purvodaya:** The **'Mission Purvodaya,'** initiated in 2020, focuses on accelerating development in eastern states with significant steel production potential.
- **Policy Initiative:** The **National Steel Policy (NSP) 2017** underscores India's ambition to become a globally competitive steel producer.
- **Protection Measures:** To protect domestic producers, import tariffs on steel products were raised, and anti-dumping and safeguard duties were imposed.

National Steel Policy 2017

(a) **Vision:** To create a technologically advanced and globally competitive steel industry that promotes economic growth.

(b) **Mission:** Provide environment for attaining:

i. Self-sufficiency in steel production by providing policy support & guidance to private manufacturers, MSME steel producers, CPSEs & encourage adequate capacity additions.
ii. Development of globally competitive steel manufacturing capabilities
iii. Cost-efficient production and domestic availability of iron ore, coking coal and natural gas
iv. Facilitate investment in overseas asset acquisitions of raw materials.
v. Enhance domestic steel demand.

(c) **Objectives:** The National Steel Policy aims at achieving the following objectives:

i. Build a globally competitive industry
ii. Increase per Capita Steel Consumption to 160 Kgs by 2030-31
iii. To domestically meet entire demand of high grade automotive steel, electrical steel, special steels and alloys for strategic applications by 2030-31
iv. Increase domestic availability of washed coking coal so as to reduce import dependence on coking coal from ~85% to ~65% by 2030-31
v. To have a wider presence globally in value added/ high grade steel
vi. Encourage industry to be a world leader in energy efficient steel production in an environmentally sustainable manner.
vii. Establish domestic industry as a cost-effective and quality steel producer
viii. Attain global standards in Industrial Safety and Health
ix. To substantially reduce the carbon foot-print of the steel industry

Way Forward

- The industry should explore alternative sources of raw materials, such as scrap metal, sponge iron, and pelletisation, to reduce the dependency on imports and improve the efficiency of production.
- The industry should invest in modernising and upgrading the transportation and distribution networks, such as railways, roads, ports, and pipelines, to reduce the cost and time of movement of raw materials and finished products.
- The industry should adopt the latest technologies and best practices, such as electric arc furnaces, continuous casting, automation, artificial intelligence, and blockchain, to enhance the productivity, quality, and sustainability of the steel production process.
- The industry should diversify its product portfolio and cater to the changing and evolving needs of the various sectors, such as construction, automotive, defence, and railways.

Copper Industry: World

The copper industry refers to the global network of activities involved in the mining, refining, production, and distribution of copper, a versatile metal widely used in various industrial sectors, including construction, electronics, transportation, and energy.

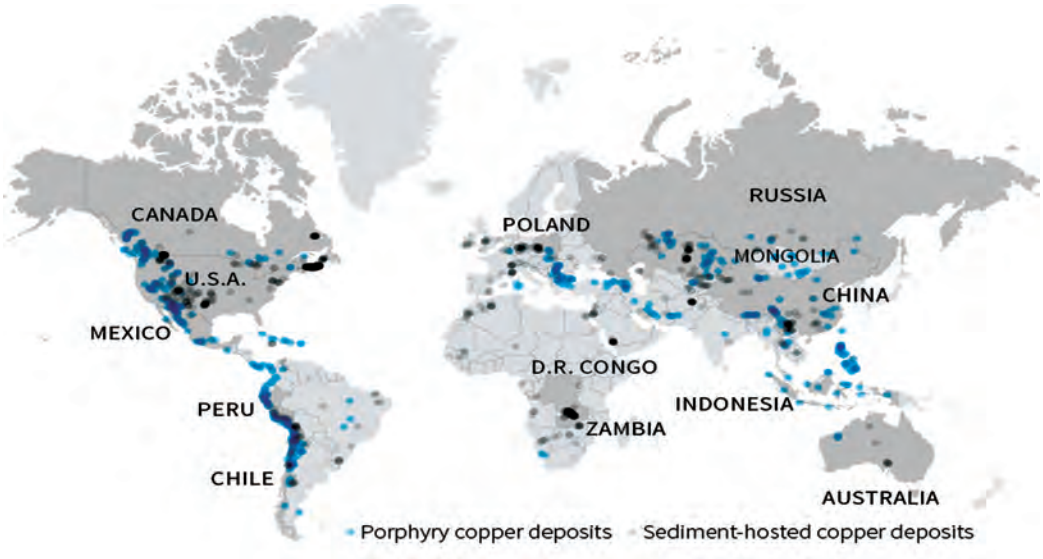


Fig. 9.24: Global Copper Industry

Distribution of Global Copper Industry

- **Chile:** Chile stands as the foremost global copper producer, contributing significantly to the world's copper supply. The nation's extensive copper reserves are predominantly situated in the Atacama Desert.
- **Democratic Republic of the Congo and Zambia:** Both Democratic Republic of the Congo and Zambia, African nations, boasted substantial copper ore reserves and established refineries for processing raw materials into valuable copper products. In an attempt to assert greater control over their natural resources and economic sectors, the governments of Democratic Republic of the Congo and Zambia opted for the nationalization of these refineries. However, the nationalization efforts did not unfold as intended, leading to financial struggles for the refineries. Mismanagement, lack of expertise, and shifting market dynamics transformed them into loss-making ventures.
- **China:** China holds a significant role in both copper production and consumption. Key copper-producing provinces in China encompass Jiangxi, Inner Mongolia, and Xinjiang.
- **Other Include:** Australia, Indonesia, USA, Canada, Russia and Mexico.

Copper Industry: India

- **Resource and Output Overview:**
  - India possesses **2% of worldwide copper reserves**.
  - The country's copper output constitutes only about **2% of global copper production**.
- **Global Standing:**
  - India ranks among the **top 20 nations** globally in terms of copper production.
  - Major importers along with countries like **China, Japan, South Korea, and Germany**.
- **Applications Driving Demand:**
  - **Versatile Applications:** Copper finds extensive use in **electrical, transportation, and construction industries**.
  - Increasing demand propelled by growth in these sectors.
- **Key Reserves:** Significant copper ore reserves are found in districts like **Singhbhum (Jharkhand), Balaghat (Madhya Pradesh), and Jhunjhunu, and Alwar (Rajasthan)**.
- **Challenges:**
  - **Environmental Concerns:** Stricter **environmental regulations** impact the industry.
  - **Land Acquisition:** Challenges in land acquisition processes.
  - **Global Price Fluctuations:** Industry vulnerability to **global copper price fluctuations**.

- **Sustainable Practices:** Emphasis on adopting **sustainable practices** in the face of challenges.
- **Opportunities for Growth:**
  - **Infrastructure Development:** Growth potential in **infrastructure projects**.
  - **Renewable Energy:** Opportunities aligned with the expansion of **renewable energy** initiatives.
  - **Electric Vehicles:** Growing demand in the era of **electric vehicles**.
  - Synergies with government initiatives like **"Make in India"** and **"Atmanirbhar Bharat"** to boost **domestic production** and reduce imports.

Location factors for Copper Industry in India

- **Abundant Copper Deposits:** Regions with rich copper ore reserves gain a competitive edge. The Malanjkhand copper deposit in Madhya Pradesh, a significant reserve, led to the establishment of the Malanjkhand Copper Project.
- **Strategic Location:** The Khetri Copper Complex in Rajasthan strategically situated near the Khetri mines, a major source of copper ore.
- **Power Supply Stability:** Reliable and cost-effective power is crucial for copper smelting and refining. Areas with access to dependable and affordable electricity, preferably from a stable grid, are preferred.
- **Infrastructure and Transportation Networks:** Adequate infrastructure, including well-connected transportation networks, is pivotal for the copper industry. The Tuticorin Port in Tamil Nadu serves as a vital hub for copper imports and exports, making it an advantageous location for copper-related industries in the region.
- **Skilled Labour Force:** A skilled labour force proficient in mining, metallurgy, engineering, and related fields is essential for the copper industry's operations.
- **Government Policies and Incentives:** Favourable Policy Environment: Government policies offering incentives such as tax breaks and subsidies can attract copper industries to specific locations.
- **Access to Markets:** Proximity to domestic and international markets is crucial for the copper industry to facilitate efficient transportation and trade.

Geographical Distribution of copper industry in india

- **Khetri, Rajasthan:** Located in the Jhunjhunu district of Rajasthan, Khetri stands as one of India's most extensive copper mining and smelting complexes.Operated by Hindustan Copper Limited (HCL), it hosts one of the country's oldest copper mines.
- **Korba, Chhattisgarh:** The Korba unit, managed by BALCO, sources its ore from Amarkantak and electricity from the Korba thermal plant.

Fig. 9.25: Copper Industry in India

- **Dahej, Gujarat:** HINDALCO, a part of the Aditya Birla Group, operates its Copper Division in Dahej, situated in the Bharuch district of Gujarat.
- **Balaghat, Madhya Pradesh:** Balaghat is home to the Malanjkhand Copper Project, one of India's largest open-pit copper mines. Operated by Hindustan Copper Limited.
- **Bhubaneswar, Odisha:** Bhubaneswar, the capital city of Odisha, accommodates the Indian Copper Complex (ICC) smelter and refinery, managed by Hindustan Copper Limited.
- **Tuticorin, Tamil Nadu** : Tuticorin in Tamil Nadu hosts the Sterlite Copper Smelter, recognized as one of India's largest copper smelters. However, the smelter has been non-operational since 2018 due to environmental concerns.

Challenges for Copper Industry

- Indian copper producers, including Hindustan Copper, Hindalco, and Vedanta, face challenges and risk shutdowns.
- Inexpensive copper imports from Japan and ASEAN countries have led to a 75% reduction in operating capacity.
- There is also a risk of job loss. As per reports around 10,000 jobs are at risk, threatening the Make In India initiative.
- Producers fear the government's free trade agreements could make India's copper industry obsolete.

Way Forward

- Copper mining poses environmental challenges like land degradation, water pollution, and community displacement. To address this, the industry must embrace sustainable and ethical practices, including emission reduction, responsible water use and waste minimization.

- The industry must invest in innovative technologies like coarse particle recovery, sulfide leaching, and machine learning for process optimization to enhance copper extraction efficiency.
- The industry should diversify copper supply by exploring recycling and untapped regions, reducing reliance on primary production. Recycling lowers the environmental impact, while exploration discovers new resources and extends mine life.

- **Urban mining:** Extract copper from discarded electronics and infrastructure, creating a circular economy and reducing reliance on virgin ore.
- **Deep-sea mining:** Utilize robotic technologies to access untapped resources, requiring stricter environmental regulations to ensure sustainability.
- **Bio-mining:** Leverage bacteria and fungi to extract copper from low-grade ores, potentially offering a more environmentally friendly option.

Aluminium Industry: World

Global Significance

- **Widespread Applications:** Aluminium is crucial in industries like **automotive, aerospace, defense, construction, electronics, packaging, and industrial applications**.
- The industry involves stages such as **bauxite mining, alumina refining, primary aluminium smelting, secondary aluminium production, and aluminium fabrication**.

Fig. 9.26: Aluminum Producing Countries of the World

Global Market Projection

- The **global aluminium market size** is expected to **reach 221.9 billion U.S. dollars by 2027**.
- **Major Producers:** China leads as the **world's largest producer of aluminum**, followed by **India, the United States, Russia, and Canada**.

Historical Shifts

- In the 1970s, **Japan, the USA, and Western Europe** dominated the industry.
- **Competitiveness Challenges:** Rising **electricity costs** in these regions posed challenges to their competitiveness.

Current Industry Status

- Expected **CAGR of 6.1%** from 2023 to 2032 in the global aluminum market.
- Market size valued at **USD 159.32 billion in 2021**, projected to grow to **USD 255.91 billion by 2029**.
- Global demand estimated to be **roughly 40 million tons by 2025**, necessitating extraction and processing of **230 million additional tons of bauxite**.

Location Factors

- **Bauxite Availability:** Nations with substantial bauxite reserves like **Guinea, Australia, and Brazil** have a competitive advantage.
- **Cheap Electricity:** Aluminium smelters strategically located near water sources and dams for **substantial energy resources**, often sourced from nearby hydroelectric power plants.

Global Distribution of Aluminium Industry

- **Asia-Pacific:** This region accounts for the largest share of global aluminium production and consumption, with China being the dominant player.
  - **China produces about 64% of the world's primary aluminium and consumes about 56% of the global demand.**
  - India, Japan, Australia, Indonesia, and Malaysia are also significant producers and consumers of aluminium in this region.
  - The Asia-Pacific region has abundant bauxite reserves, especially in Australia, Indonesia, and India, as well as low-cost labour and energy sources.
- **Europe:** This region is the second-largest producer and consumer of aluminium in the world, with Russia, Norway, Germany, France, and Iceland being the main contributors.
  - Europe has limited bauxite resources, but Iceland possesses significant reserves.
  - Iceland has become an appealing destination for Aluminium companies due to abundant, low-cost, and renewable energy sources.
- **North America:** This region is the third-largest producer and consumer of aluminium in the world, with Canada, the United States, and Mexico being the key players.
  - The United States, with its expansive geography, hosts Aluminium production centers in various

regions. Historically, the eastern USA (Arkansas, Georgia, Alabama) and western USA (Arizona, Utah, New Mexico) have been associated with Aluminium production.

- North America has moderate bauxite reserves, mainly in Jamaica, but it also relies on imports from other regions.

- **South America:** This region is a major exporter of bauxite and alumina, but a minor producer and consumer of aluminium. Brazil, Venezuela, Guyana, and Suriname are the main sources of bauxite and alumina in this region.
- **Middle East and Africa:** This region is a net importer of aluminium, but it has some potential for growth in the future. The United Arab Emirates, Bahrain,
  - Saudi Arabia, and Egypt are the main producers of aluminium in this region.
  - The Middle East and Africa have limited bauxite resources, but they have access to cheap and abundant natural gas, which is used for aluminium smelting.

Aluminium Industry: India

- Aluminium is a crucial strategic metal in India's economy also, ranking as the second most important industry after iron and steel. Its versatile applications range from electricity production and household items to aircraft manufacturing and defence equipment. The industry has experienced rapid growth, with nearly a 20-fold increase over the last 60 years, surpassing other metals.
- It has significant downstream impacts, creating numerous jobs and supporting thousands of small and medium-sized enterprises. India is also the seventh-largest holder of bauxite reserves, the primary raw material for aluminium, and has established the **National Mineral Exploration Trust** to ensure a steady supply of raw materials for the industry's expansion. Overall, aluminium plays a pivotal role in India's economic growth and technological development.

State	Bauxite Production Areas
Orissa	Kalahandi, Koraput, Andhra Pradesh
Jharkhand	Ranchi, Lohardaga, Palamu, Gumla Dumka, Munger
Maharashtra	Kolhapur, Udgeri, Dhangarwadi, Radhanagari, Inderganj
Chhattisgarh	Maikala range (Bilaspur, Durg), Amarkantak plateau (Surguja, Raigarh, Bilaspur)
Madhya Pradesh	Amarkantak plateau, Maikala range (Shahdol, Mandla, Balaghat), Kotni (Jabalpur)
Other States	Andhra Pradesh (Visakhapatnam, East Godavari, West Godavari), Kerala (Kannur, Kollam, Thiruvananthapuram), Rajasthan (Kota), Uttar Pradesh (Banda, Lalitpur, Varanasi), Jammu and Kashmir (Jammu, Poonch, Udhampur), Goa

Main Aluminium producing units in India

- The Aluminium smelting sector holds the second most significant position in India's metallurgical landscape, coming after the iron and steel industry. It plays a pivotal role in the overall growth of the nation's industrial sector.
- Its contribution is crucial to the comprehensive development of India's industrial sector. It occupies the second most important position in the country's metallurgical landscape, with the iron and steel industry taking the lead.
- Both private and public sector enterprises are present in Aluminium production- HINDALCO, NALCO, MALCO, BALCO etc.

Challenges

- High energy costs and dependence on coal-based power generation, which contributes to the sector's high carbon footprint and emissions.
- Lack of adequate infrastructure and logistics for transporting raw materials and finished products, which increases operational costs and delays.
- Low recycling rates of aluminium scrap, which leads to wastage of resources and missed opportunities for reducing emissions and energy consumption.

Way Forward

- Switching to renewable energy sources or carbon capture technologies to decarbonize the electricity consumption and reduce emissions.
- Developing and deploying innovative technologies and processes, such as non-carbon anodes, inert anodes, and carbothermal reduction, to eliminate or minimize the direct emissions from aluminium production.

Cement Industry: World

The cement industry is a vital sector for the construction of infrastructure and buildings. It produces a durable and versatile material that can bind coarse aggregates like sand, gravel, and steel. Cement is also used for making concrete, mortar, and plaster.

The cement industry is a global industry, with production and consumption occurring in various regions. According to the web search results, some facts about the cement industry are:

- The global cement production was 4.1 billion metric tons in 2022.

- India is the second-largest cement producer in the world, after China.In 2022, India's cement production was 356 million tons, which is more than 7% of the world's installed capacity.
- The cement industry in India contributes about 8% of the GDP and employs over 10 million people.

Other prominent Cement producing countries

1. **United States:** The United States is the world's third-largest cement producer, with a production of around 114 million metric tons in 2022. The US cement industry is mature and stable, and is expected to grow slowly in the coming years.
2. **Vietnam:** Vietnam is the world's fourth-largest cement producer, with a production of around 113 million metric tons in 2022. The Vietnamese cement industry is growing rapidly, driven by the country's strong economic growth and urbanization.
3. **Indonesia:** Indonesia is the world's fifth-largest cement producer, with a production of around 78 million metric tons in 2022. The Indonesian cement industry is also growing rapidly, driven by the country's large population and government spending on infrastructure development.

Cement Industry: India

- India stands as the world's second-largest cement producer, boasting an impressive share of over 8% of the global installed capacity. The country holds vast potential for infrastructure and construction development, with the cement industry poised to reap substantial benefits from this growth.
- Moreover, driven by increasing demand for rural housing, cement consumption in India has maintained consistent growth, largely owing to its affordability in terms of cost per kilogram.
- Consequently, the cement sector appears primed for sustained long-term demand expansion. Recent initiatives like the ambitious plan to develop 98 smart cities are anticipated to play a pivotal role in catalyzing the sector's growth further.
- In India, there is a collective presence of 210 substantial cement plants, with 77 of them strategically located in the states of **Andhra Pradesh, Rajasthan, and Tamil Nadu.**
- **South India** hosts a significant portion, accounting for approximately 32% of the country's cement production capacity, while North India contributes 20%, Central India 13%, and West India 15%. The remaining 20% finds its establishment in the eastern regions of the country.

Fig. 9.27: Chemical Industries (Cement, Drugs & Pharma) in India

Locational Factors for Cement Industry

- **Availability of Raw Materials:** Limestone, clay, and gypsum play significant roles in large quantities in the production of cement. Therefore, cement plants like Ultratech Cement and Ambuja Cement strategically position themselves in regions abundant in these raw materials, such as Rajasthan, known for its limestone wealth.
- **Infrastructure and Transportation:** Efficient transportation of the produced cement to the market is crucial due to its weight and bulk. A well-developed network of roads, railways, or ports (for export purposes) is essential to facilitate the transportation of cement.
- **Power Availability:** Given the energy-intensive nature of cement manufacturing, the industry gravitates towards regions with a reliable and cost-effective energy supply. This often includes access to resources such as coal, hydroelectricity, or renewable energy.
- **Water Availability:** A sufficient water supply is a necessity in the cement manufacturing process, particularly for cooling purposes. Therefore, cement plants strategically position themselves near water sources, such as rivers or lakes.
- **Government Policies**: Government policies and regulations wield influence over the location choices of cement industries. Environmental regulations, tax incentives, and subsidies can either encourage or discourage the establishment of cement plants in specific regions.
- **Environmental Factors:** Considering that the cement industry is recognized as a polluting one, the presence of air pollution regulations can impact its location. Cement plants tend to avoid states with stringent air pollution requirements.
- **Geological Considerations:** Geological factors, particularly the quality and composition of limestone deposits, are critical considerations influencing the decisions regarding the location of cement plants.

New Opportunities for the Cement Industries

- The Ministry of Transport has decided to build concrete cement roads instead of traditional bitumen roads as cement roads are cost-effective & require less maintenance.
- Rapid urbanisation and infrastructure development have increased the demand for Cement in India.
- Government programs like "**Housing for All**" have increased the cement demand in India.
- India is exporting cement to its neighbouring countries like Nepal, Bangladesh, Sri Lanka, and Bhutan, as well as to markets in the Middle East, Africa, and Southeast Asia.

Challenges

- The cement industry is a significant contributor to carbon emissions, air pollution, and water consumption.
- The cement industry requires large tracts of land for mining, manufacturing, and transportation of raw materials and finished products. However, acquiring land in India is a complex and time-consuming process, involving multiple stakeholders, legal hurdles, and social issues.

Way Forward

- Adopting more energy-efficient and eco-friendly technologies and processes to reduce carbon emissions and waste generation.
- Improving the supply chain management and distribution channels to overcome the issues of land acquisition, transportation, and logistics.

Gems & Jewellery Industry: World

- The gems and jewellery industry is a diverse global market involving mining, processing, trading, and retailing. Valued at USD 415.09 billion by 2028, it's fueled by factors like rising incomes, urbanization, shifting consumer preferences, and increased online sales.
- According to IBEF, the top gems and jewellery exporters in 2022-23 were the USA, Hong Kong, UAE, Belgium, Singapore, Israel, Thailand, UK, Switzerland, and the Netherlands, contributing over 90% of India's exports in this sector. The USA led the market, trailed by Hong Kong and UAE.

Gems & Jewellery Industry: India

- India's gems & jewellery market size is expected to reach US$ 100 billion by 2025. The Gems and Jewellery sector plays a significant role in the Indian economy, contributing around 7 per cent of the country's GDP and 15 per cent to India's total merchandise exports.
- As per the 2020 statistics, India's gems and Jewellery exports account for **3.5% of the world's total exports,** making it among the top 7 highest exporters in the world.
  - Diamond jewelry ranks first in the world's total exports with a 29.0% share, followed by silver-cut diamonds and lab-grown diamonds and synthetic stones with 22.0% and 32.7% shares, respectively.
- It also employs over 4.64 million workers and is expected to employ 8.23 million by 2022. One of the fastest-growing sectors, it is extremely export-oriented and labour-intensive.
- The Indian government presently allows 100 per cent Foreign Direct Investment (FDI) in the sector through the automatic route.
- India's gems and jewellery sector are one of the largest in the world contributing **29 per cent to global jewellery consumption.**

Major jewellery clusters in India

- **Mumbai:** The largest centre for gold jewellery and diamond cutting and polishing, accounting for 65% of the total value of diamond exports and 40% of the total value of gold jewellery exports.
- **Surat:** The world's largest diamond cutting and polishing hub, processing 14 out of every 15 rough diamonds in the world.
- **Jaipur:** The largest centre for coloured gemstones, especially emeralds, rubies, and sapphires, as well as kundan and meenakari jewellery.
- **Kolkata:** The main centre for handmade gold jewellery, especially filigree work, and also a major exporter of costume jewellery.
- **Coimbatore:** The largest producer of machine-made gold jewellery, catering to the domestic and export markets.
- **Thrissur:** The hub of plain gold jewellery manufacturing, supplying to over 80% of the jewellery retailers in South India.
- **Hyderabad:** The centre for pearl jewellery and studded jewellery, as well as silver filigree work.

Other important jewellery clusters in India include Delhi, Ahmedabad, Rajkot, Jamnagar, Chennai, Bangalore, and Indore.

Locational Factors for Gems & Jewellery Industry

- **Gemstone presence:** Proximity to mines or alluvial deposits of desired gemstones like diamonds (South Africa, Russia), emeralds (Colombia, Zambia), sapphires (Sri Lanka, Madagascar), etc. drives initial industry concentration. E.g., Surat in India is a diamond hub due to its historical proximity to Golconda mines.
- **Gold & metal availability:** Access to precious metals like gold, platinum, and silver for crafting jewellery is crucial. E.g., Italian jewellery industry historically benefited from abundant Alpine gold deposits.
- **Artisanal heritage:** Regions with long-standing traditions in gem cutting, polishing, and jewellery making like Jaipur in India and Antwerp in Belgium attract skilled artisans and foster industry growth.
- **Design & innovation:** Centres attracting renowned designers and fostering creative jewellery trends, like Milan in Italy, become hubs for high-end jewellery production.
- **Cost competitiveness:** Access to cheap labour, tax benefits, and government support can attract manufacturers. E.g., Thailand's gem cutting industry benefits from skilled labour and tax incentives.

Challenges

- India imports most of its raw materials, such as gold, diamonds, and gemstones, from other countries, making it vulnerable to fluctuations in exchange rates, import duties, and global supply and demand.
- The industry is dominated by the cut and polished diamonds segment, which accounts for more than 60% of the total exports, while other segments, such as gold jewellery, coloured gemstones, and silver jewellery, have lower shares and growth rates.
- The industry relies heavily on manual labour and traditional methods of crafting, which are time-consuming, inefficient, and prone to errors and quality issues.

Way forward

- Diversifying the product portfolio and exploring new markets and segments, such as artificial and imitation jewellery, online and digital platforms, and niche and premium segments.
- Enhancing the value addition and moving up the value chain, by investing in technology, innovation, design, branding, and marketing.
- Improving the organization and formalization of the industry, by registering the units and workers, maintaining data and records, and implementing standards and best practices.

CHEMICAL BASED INDUSTRY

India's chemical industry, which covers over 80,000 commercial products, is a diversified sector **contributing 7% to its GDP.** It can be classified into bulk chemicals, speciality chemicals, agrochemicals, petrochemicals, polymers, and fertilisers. The industry is expected to grow to $300 billion by 2025 and $1 trillion by 2040.

India is the fourth-largest producer of agrochemicals globally, accounting for 16-18% of the world's production of dyestuffs and dye intermediates. The Indian colourant industry has a global market share of around 15%. The industry is de-licensed, except for hazardous chemicals. India ranks 14th in exports and 8th in imports globally, excluding pharmaceuticals.

Petrochemical Industry: World

- The petrochemical industry is a branch of the chemical industry that uses raw materials from oil refining and gas processing to produce a wide range of products, such as plastics, synthetic fibers, fertilizers, adhesives, dyes, detergents, and synthetic paints and coatings.
- The petrochemical industry is a major component of the global energy system, accounting for more than 16 percent of the oil demand in the OECD in 2020. The global petrochemicals market size was valued at USD 599.68 billion in 2022, and is expected to grow to 1.5 trillion U.S. dollars by 2030.

- The **largest petrochemical industries** are located in the **United States and Western Europe,** but major growth in new production capacity is in the Middle East and Asia. There is substantial inter-regional petrochemical trade.
- The most important petrochemical products include ethylene, propylene, methanol, benzene, and xylene. These products are used as building blocks for various downstream products, such as polyethylene, polypropylene, methanol derivatives, styrene, and polyester.

Petrochemical Industry: India

- It is one of the sectors in India's economy that has grown rapidly. The Indian petrochemical sector has had exceptional growth since its inception.
- India is the sixth-largest participant in the global petrochemical industry, with a market size of over USD 190 billion.
- Strong macroeconomic foundations and population expansion in India are key enablers for the development of a hub for the production of petrochemicals. This industry has a significant impact on both the growth and development of the manufacturing sector as well as the national economy.
- It serves as a foundation for various other sectors such as construction, packaging, medicines, agriculture, textiles, and other manufacturing businesses.

Fig. 9.28: Refineries in India

- The India's petrochemical industry is highly concentrated and oligopolistic in nature. Four companies viz. Reliance Industries Ltd (RIL), Indian Petrochemicals, Corporation Ltd. (IPCL), Gas Authority of India Ltd. (GAIL) and Haldia Petrochemicals Ltd. (HPL) used to dominate the industry to a large extent. India ranks among the world's countries with the lowest per capita consumption of petrochemical products.
- The petrochemical industry in India is grappling with numerous hurdles that prevent it from surpassing other Asian countries. Given that petrochemicals and their derivatives form the foundation of infrastructure, industry, services, and agriculture, their contribution to the Indian economy is vital for India in order to achieve a $5 trillion economy by 2024–2025.

Locational Factors responsible for Petrochemical Industry

- **Location of Oil Refineries:** Petrochemical industries strategically position themselves near oil refineries to acquire raw materials derived from the by-products of crude oil and natural gas refining. The proximity allows for the growth of downstream industries, particularly those utilizing naphtha as a chief raw material.
- **Availability of Power Resources:** The growth of the petrochemical industry is significantly influenced by the easy accessibility of power resources.
- **Capital:** Substantial capital investments are a prerequisite for the expansion of the petrochemical industry. Both state and central governments, as well as affluent industrial groups, contribute to these significant financial requirements.
- **Advanced Technology and Technical Skills:** The development and increased output of the petrochemical industry hinge on advanced technology and the presence of proper technical skills.
- **Demand:** The petrochemical industry experiences growth due to high demand for its products in both domestic and international markets.

- **Skilled Labourers:** Effective execution of the production process in the petrochemical industry requires a skilled labour force.
- **Efficient Transport System:** An efficient transport system, including close proximity to ports, well-developed roadways, and railways, plays a crucial role in the development of the petrochemical industry. This facilitates the easier import, export, and distribution of goods.

Challenges

- High cost of energy and feedstock, which affects the competitiveness and profitability of the industry.
- Lack of specialized infrastructure, such as pipelines, water desalination plants, and effluent treatment facilities, which hampers the production and transportation of petrochemicals.
- High excise duty on synthetic fiber, which discourages the domestic consumption and export of the product.

Government Measures

- Introducing the Hydrocarbon Exploration Licensing Policy (HELP), which provides a uniform licensing system for all hydrocarbons, such as oil, gas, coal bed methane, etc. under a single framework.
- Allowing marketing and pricing freedom for new gas production from deepwater, ultra deepwater and high pressure-high temperature areas.
- Granting extension to the production sharing contracts for small, medium sized and discovered fields.

Way Forward

- Developing petrochemical hubs and clusters, which would provide integrated infrastructure and facilities for the industry.
- Promoting the use of alternative feedstocks, such as natural gas, coal, and biomass, which would reduce the dependence on imported crude oil and naphtha.

Fertilizer Industry

World

- The fertilizer industry is a vital sector for the global agriculture, as it provides essential nutrients for crop growth and soil fertility.
- The global fertilizer market size was estimated at USD 193.8 billion in 2020 and is expected to reach USD 543.2 billion by 2030, growing at a CAGR of 5.93%.
- The main fertilizer nutrients are nitrogen, phosphorus, and potassium, which account for about 85% of the total fertilizer consumption worldwide.

Major Fertilizer Producing Countries

- **China: By far the world's largest producer,** China churns out over 53 million tonnes of fertilizer annually. This massive output is driven by their large population and focus on intensive agriculture.
- **India: Coming in third** with around 31 million tonnes, India's fertilizer production is crucial for feeding its vast population.
- **United States:** The US produces roughly 12.7 million tonnes of fertilizer, supporting its significant agricultural sector and exports.

Fig. 9.29: Fertilizer Plants in India

- **Indonesia:** Indonesia produces around 11 million tonnes, primarily to meet its domestic demand for food crops like rice and palm oil.
- **Brazil:** A major agricultural exporter, Brazil produces 8.7 million tonnes of fertilizer to nourish its crops and maintain its position in the global market.

India:

- **India ranks as the third-largest producer of fertiliser** worldwide this emphasises the importance of India in the manufacturing of fertiliser worldwide.
- The fertiliser sector is regarded as one of India's essential businesses, particularly in light of the pivotal role it played in advancing the Green Revolution, which revolutionised Indian agriculture.
- Most of the Industries are strategically placed next to the petrochemical industry as this closeness makes it possible for plants to efficiently acquire basic materials, like as ammonia, a crucial component of nitrogenous fertilisers.

Locational Factors of Fertiliser Industry

- **Presence of Oil Refinery:** About 70% of nitrogenous fertilizer plants utilize naphtha as the primary raw material. For instance, fertilizer plants in the Gujarat-Maharashtra region, such as those in Hazira, Mumbai, Trombay, and Vadodara, exemplify this reliance.
- **Proximity to Natural Gas Source:** The necessity of natural gas for producing urea and nitrogen-based fertilizers underscores the importance of proximity to a natural gas source.
- **Presence of Iron and Steel Industry in the Vicinity:** Certain fertilizer plants derive feedstock from steel slugs, coke, and lignite, emphasizing the significance of having an iron and steel industry nearby.
- **Pipeline Infrastructure:** In recent years, the transportation of naphtha or gas through rail or pipelines has facilitated the widespread distribution of fertilizer plants, with priority given to seaboard locations. The Hazira-Bijaipur-Jagdishpur (HBJ) pipeline is an example, leading to the development of fertilizer industries in Bijapur, Sawai Madhopur, Shahjahanpur, etc.
- **Port Facilities:** Some fertilizer plants rely on the import of phosphate, potash, etc. Additionally, many fertilizer plants export their produce to other countries via seaports and pipelines.
- **Raw Materials:** The availability of mineral phosphate and raw potash materials is crucial. For instance, locations such as Florida, North Carolina, Utah, and Idaho, along with regions in India like Uttar Pradesh, Madhya Pradesh, and Rajasthan, exemplify this availability.

Reasons for locating fertiliser plants near natural gas sources are:

- **Essential Feedstock:** Fertilizer plants predominantly utilize gas as a feedstock, distinguishing them from power plants that burn gas as fuel. Unlike the burning of gas as fuel in power plants, where all carbon is converted to carbon dioxide and released into the atmosphere, in fertilizer production, carbon dioxide is transformed into urea and is not emitted into the atmosphere.
- **Efficient Fuel:** Natural Gas offers numerous advantages, including higher thermal efficiency, a shorter gestation period, higher plant load factor, lower capital costs, and minimal emissions for both local and global environments. Its lighter-than-air property also makes it a safe fuel to use.
- **Clean Mechanism:** Methane, being 25 times more potent than carbon dioxide as a greenhouse gas, is eliminated through the process.

Current status of Fertilizer Industry

- The Indian fertilizers market is anticipated to achieve a **Compound Annual Growth Rate (CAGR)** of 11.9% during the forecast period (2021-2026). The Indian fertilizer market size reached INR 942.1 Billion in 2023.
- Significant strides have been made in the Indian fertilizer industry, particularly in the domain of Nitrogen-based fertilizers. India stands as the second-largest consumer of Urea fertilizers globally, trailing only behind China. The country holds the second position in nitrogenous fertilizer production and the third position in phosphatic fertilizer production.
- Given the limited reserves of potash, India meets its potash requirements through imports. The production of potash is predominantly under state control.
- Prominent **Public Sector Undertakings (PSUs)** contributing to the Indian fertilizer industry include The Fertilizer Corporation of India Ltd, National Fertilizers Limited, Hindustan Fertilizer Corporation Ltd., among others.

Challenges in the Fertilizer sector

- **Price Distortion and Shift in Fertilizer Composition:** Price differences favoring urea over Potassium and Phosphorus have skewed fertilizer composition. Fertilizer use per hectare varies significantly across regions, deviating from recommended NPK mix.
- **Rising Fertilizer Subsidy:** Updated data maybe used the Union Budget for FY24 had allotted around Rs 1.75 lakh crore towards fertiliser subsidy. Rising energy and international fertilizer prices, coupled with import dependence, strain fiscal resources. Taxpayers cover 78% of urea costs.
- **Import Dependence and Production Gap:** India faces a production gap for urea and DAP, with demand exceeding domestic production. Limited irrigation expansion and outdated technology in fertilizer industry operations hamper growth.

Steps taken by Government in the Fertiliser Sector

- **One Nation One Fertilizer (ONOF):** Union Ministry mandates 'One Nation One Fertilizer' scheme, requiring single brand and logo for all subsidized fertilizers like UREA, DAP, MOP, NPK. 'BHARAT' brand to be uniformly used across all companies, with PMBJP logo displayed on bags.

- **Nutrient-Based Subsidy Scheme:** Under the Nutrient Based Subsidy (NBS) regime, farmers receive fertilizers at subsidized rates, determined based on the nutrients (N, P, K & S) present in the fertilizers. Furthermore, fertilizers fortified with secondary and micronutrients like molybdenum (Mo) and zinc are eligible for additional subsidies.

Pharmaceutical Industry

World

- The pharmaceutical industry is a global sector that researches, develops, produces, and markets drugs for various medical purposes. The industry has grown significantly in the past two decades, reaching a revenue of 1.48 trillion U.S. dollars in 2022.
- The industry is composed of different segments, such as prescription drugs, over-the-counter drugs, biopharmaceuticals, and generics.

Top countries in pharma industry sector

- **United States:** The United States is the world's **largest** pharmaceutical market, accounting for over 40% of global sales. It is also home to many of the world's largest pharmaceutical companies, such as Pfizer, Johnson & Johnson.
- **China**: China is the world's **second**-largest pharmaceutical market, and is expected to continue to grow rapidly in the coming years.
- **Japan**: Japan is the world's third-largest pharmaceutical market, and is known for its high-quality drugs and research. Japanese pharmaceutical companies are particularly strong in areas such as antibiotics and oncology.
- **United Kingdom:** The United Kingdom is a major player in the global pharmaceutical industry. British pharmaceutical companies are known for their focus on research and development, and for their innovative products.
- **India**: India is a major producer of generic drugs, and is a growing player in the global pharmaceutical industry. Indian pharmaceutical companies are known for their low-cost drugs, and are making inroads into developed markets..
- **France**: France is another major player in the European pharmaceutical industry. French pharmaceutical companies are known for their focus on research and development, and for their innovative products.
- **Germany**: Germany is a major player in the European pharmaceutical industry, and is home to many of the world's largest pharmaceutical companies.

Way Forward

- Enhancing domestic production and reducing import dependence by promoting investment, innovation, and diversification in the fertilizer sector.
- Promoting balanced and efficient use of fertilizers by adopting soil testing, nutrient management, and precision farming practices.

Fig. 9.30: Leading Pharmaceutical Markets of the world

India

- Globally, the Indian pharmaceutical sector is renowned for its affordable vaccines and generic medicines. India has the **third-largest pharmaceutical market in terms of volume** and the **fourteenth-largest pharmaceutical market in terms of value.**
- Currently, the pharmaceutical industry contributes to **1.72% of the nation's GDP.** India has 500 Active Pharmaceutical Ingredients (API) makers, which account for around 8% of the global API industry.
- India has the **highest number of pharmaceutical production facilities** that are in accordance with the US Food and Drug Administration (USFDA). The Indian pharmaceutical business is divided into many different sectors, including generic pharmaceuticals, over-the-counter medicines, bulk drugs, vaccines, contract research & production, biosimilars, and biologics.

Locational factors for Pharmaceutical Industry in India

- **Availability of Raw Material:** Optimal locations ensure the abundant availability of necessary raw materials for efficient product manufacturing. This guarantees a steady supply and minimizes transportation costs.
- **Nearness to the Potential Market:** Efficient marketing of finished goods is crucial for business success. Locating the plant close to the market enables better management insight into market changes, facilitating informed

production policies. Using the example of the Indian pharmaceutical industry, proximity to the western coast allows easy export to Africa and Europe via well-connected ports like Kandla and Bhavnagar.

- **Location Near the Source of Operating Power:** Certain industrial operations require cheap, continuous, and ample power. Plant locations near hydel-power sources ensure access to affordable electricity.
- **Supply of Labour:** Adequate and cost-effective labour is vital for industrial success..
- **Transport and Communication Facilities:** Well-connected regions with rail, road, water, and air transport systems are deemed suitable for plant locations.
- **Suitability of Land and Climate:** The sub-soil should support the expected load, and climate conditions like humidity and temperature should be favorable. The example is given that a humid atmosphere is not suitable for pharmaceutical manufacturing.
- **Local Building and State Policy Regulations:** Compliance with local regulations, construction laws, and considerations of local taxes are essential for site selection. State government policies, such as the stable policies in Gujarat and Maharashtra, also influence industrial locations.
- **Safety Requirements:** Industries with pollution or explosive processes should be located in remote areas to meet safety standards.
- **Indian Pharmaceutical Industry Example:** The Indian pharmaceutical industry strategically locates itself along the western coast, ensuring proximity to raw materials, efficient market access through various transportation modes, and availability of skilled and unskilled labour. The stable policies of states like Gujarat and Maharashtra contribute to its favorable business environment.

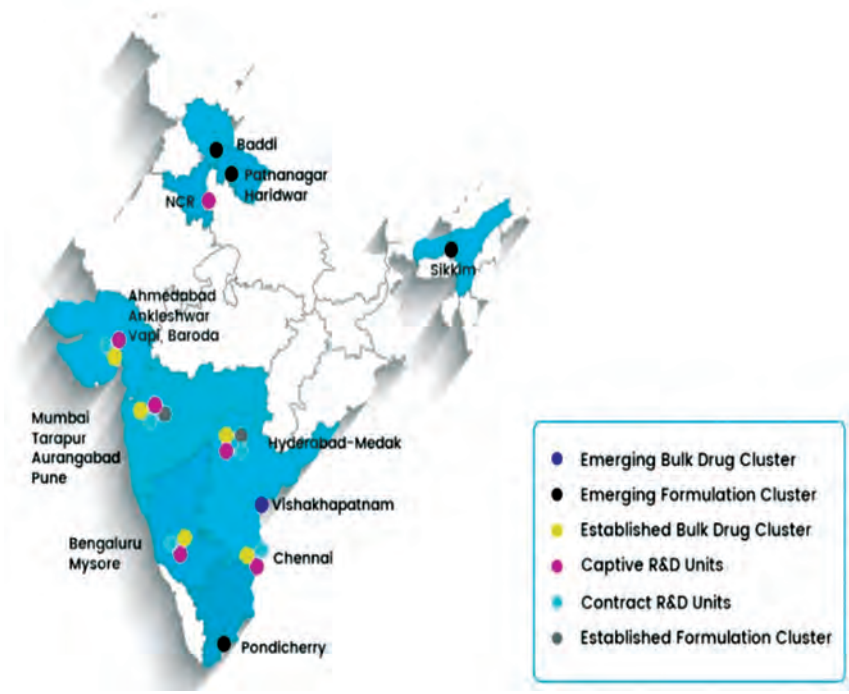


Fig. 9.31: Pharma Clusters of India

Current Status of Pharma Sector

- India holds the position of being the largest provider of generic drugs worldwide. It caters to over 50% of the global demand for various vaccines, supplies 40% of the generic demand in the United States, and contributes to 25% of all medicine in the United Kingdom.
- The Indian pharmaceutical market is valued at USD 50 billion, with an additional USD 20 billion in exports by pharmaceutical companies. However, this constitutes a small fraction of the USD 1.27-trillion global pharmaceutical market.
- On a global scale, India ranks 3rd in terms of pharmaceutical production by volume and 14th by value. Despite having over 20% share in the global generic market, India's presence in the new molecular entity space is less than 1%.
- New Molecular Entity, defined as a novel compound not previously approved for use in humans, is an area where India holds less than a 1% share, despite having a significant presence in the global generic market.
- According to the Economic Survey of 2021, the domestic pharmaceutical market in India is anticipated to triple in size over the next decade.

Problems of Pharmaceutical Industries in India

- **Technology**: In the realm of Research and Development (R&D) for new medicines, the Indian pharmaceutical sector significantly lags behind other World Trade Organization (WTO) countries. There has been limited emphasis on research and innovation.
- **Raw Materials Deficiency:** Despite being a key supplier of high-quality medicines globally, the Indian pharmaceutical industry faces a substantial reliance on China for raw materials, specifically Active Pharmaceutical Ingredients (API) or bulk drugs. Approximately 70% of Indian drug-makers' bulk drug requirements are imported from China.
- **USTR Watch List:** The Office of the United States Trade Representative (USTR) has placed India on its priority watch list in its special 301 report, adversely impacting the Indian pharmaceutical industry.

Way Forward

- Increase R&D investment for groundbreaking drug development, especially in biologics, biosimilars, and specialty drugs. Collaborate with academia, government, and other stakeholders to create an ecosystem that fosters innovation and talent development.
- Embrace digital technologies and enhance manufacturing facilities to improve productivity, efficiency, and quality. Adopt industry 4.0 solutions, such as automation, artificial intelligence, and blockchain, to optimize processes and data management.

Cottage Industry

- The Cottage industry is the production of finished goods by workers or families at home, with a long history in India. It involves family labour and aims to increase income with minimal investment. Important cottage industries in India include bidi-making, sports goods, basket-making, lac industry, cracker manufacturing, paper machines, perfumery, needlework on shawls, and wearings.
- Raw materials for bidi include tendu leaves and kachina, found in forests of Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, and Western and Eastern Ghats. India exports bidi to Asian, African, and European countries.
- The cottage industry also produces equipment for athletics goods, including basketball, cricket, tennis, badminton, baseball, billiard, carrom, chess, dart, football, golf, gymnastics, squash, volleyball, and water polo. This cottage industry is majorly present in the states such as Assam, Chhattisgarh, Gujarat, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Mizoram, Nagaland, Odisha, Sikkim, Tripura, Uttar Pradesh, Uttarakhand and West Bengal.

Locational factors of cottage and agro-based industry in India

- **Availability of Raw Materials**: Industries rely on materials like wood, bamboo, cane, jute, cotton, and silk. Regions like North-Eastern India (Assam, Tripura, Meghalaya) offer diverse materials, ideal for production.
- **Skilled Labour:** Success depends on skilled workers. Rural areas in states like Uttar Pradesh, Bihar, and West Bengal possess skilled labour, crucial for these industries.
- **Market Access:** Accessibility to local, national, and international markets is vital. Indian industries have access to both local and national markets, with increasing demand for eco-friendly products.
- **Infrastructure**: Basic amenities like roads, electricity, and water are essential. Indian government initiatives aim to improve rural infrastructure, benefiting these industries.

Khadi & Village Industries Commission (KVIC)

- It is a statutory body formed in April 1957 by the Government of India, under the Act of Parliament, 'Khadi and Village Industries Commission Act of 1956'.
- Its mission is to provide employment opportunities in rural areas by promoting and developing khadi and village industries (KVIs).
- KVIC implements various schemes and programs to achieve its objectives, including providing financial assistance, training, and marketing support to artisans and entrepreneurs.
- Some of the key products produced by KVIs include khadi (handspun and handwoven cloth), silk, handicrafts, pottery, and food products.
- KVIC products are sold through a network of retail outlets across India.

- **Government Policies:** Policies including subsidies and tax incentives influence industry growth. The Indian government supports these sectors through entities like Handicrafts Boards and the Khadi and Village Industries Commission.

Electronics Industry

World

- The electronics industry is the economic sector that produces electronic devices, such as computers, smartphones, TVs, radios, and more. It is one of the largest and fastest-growing industries in the world, with a projected value of $790 billion by 2030.
- Some of the major countries that contribute to the electronics industry are China, Hong Kong, the U.S., Japan, South Korea, Taiwan, and India. China is the leader in electronics production, accounting for about 30% of the global market share. India is one of the fastest-growing markets, with a strong demand for consumer electronics and a supportive policy environment for domestic manufacturing.

Top Countries in the Electronics Industry

- **China:** China is the undisputed leader in electronics manufacturing, accounting for over 30% of global electronics exports. It has a vast and well-developed supply chain, making it a one-stop shop for many electronics companies. Some of the major Chinese electronics manufacturers include Foxconn, Huawei, and Xiaomi.
- **United States:** The United States is a leader in electronics innovation and design, home to tech giants like Apple, Google, and Microsoft. It is also a major producer of high-end electronics, such as semiconductors and medical equipment.
- **Japan:** Japan is a pioneer in electronics technology, with a long history of innovation in areas like display technology, robotics, and semiconductors. Some of the major Japanese electronics companies include Sony, Panasonic, and Toshiba.
- **South Korea:** South Korea is a major player in consumer electronics, known for its smartphones, TVs, and memory chips. Some of the major South Korean electronics companies include Samsung, LG, and SK Hynix.
- **Taiwan:** Taiwan is a major producer of semiconductors, which are essential components in most electronic devices. It is also home to a number of contract manufacturers, such as TSMC, which produce electronics for other companies.
- **Germany:** Germany is a leader in industrial electronics, known for its automation equipment, machine tools, and medical devices. Some of the major German electronics companies include Siemens, Bosch, and Infineon.
- **Singapore:** Singapore is a major trading hub for electronics, with many companies setting up regional headquarters and factories there. It is also a growing center for innovation in areas like artificial intelligence and robotics.

India

- In order to reach its goal of having a $1 trillion economy by 2025, India needs to manufacture $300 billion worth of electronics by FY26. The domestic electronics market was valued at $118 billion as of FY20, according to the Economic Survey 2022–23.

ESDM Map of India

Fig. 9.32: Electronics, Semiconductors Design & Manufacturing(ESDM) Map of India

- Mobile phones, consumer electronics, and industrial electronics are the key growth factors in this sector. India is now the second-largest mobile phone producer in the world after China, with a rise in handset manufacturing from 6 crore units in FY 15 to 31 crore units in FY 22.
- The government offers initiatives and incentives to boost the electronics manufacturing base, such as the PLI scheme for large-scale manufacturing, the PLI scheme for IT hardware, the scheme for promotion of manufacturing of electronic components and semiconductors (SPECS).

Locational factors for Electronics Industry

- **Labour :** Skilled labour is needed to perform necessary operations. The cost of labour should not be very high.
- **Technology :** It is required to convert silicon wafers to chip form in a cost-effective manner.
- **Government support :** It incentivises companies to invest in research and development.
- **Export facility:** Good transport connectivity is needed since these industries are part of global value chains.

Status of Electronics Industry

- India emerges as a major global market for electronic products. the electronics market in India is valued at $155 Bn with domestic production accounting for 65% in 2023-24, segmented into Mobile Phones, Consumer Electronics, Strategic Electronics, Computer Hardware, LEDs, and Industrial Electronics.
- Mobile phone production experiences over 5x growth in five years, reaching approximately 300 million units in FY21.
- Digital transactions per capita per annum increase ~10x in five years, showcasing rapid digitalization.
- India establishes itself as a global R&D destination, hosting 1140+ R&D centers of multinational corporations.
- Electronic goods exports valued at $1395.09 million in May 2022, showing a positive growth of 47.37% compared to May 2021, highlighting India's growing presence in the global electronic goods market.

Challenges

- Despite the rapid growth in electronic manufacturing in India, the net value added by manufacturing units remains notably low, ranging between 5% and 15%.
- Upstream industries, especially in electronics, experience low value addition at the final stages of production due to complex processes. Components such as processors, display panels, memory chips, and cameras are predominantly imported, with China contributing approximately 67% of all imports.
- India's reliance on imported chips and components for crucial systems raises national security concerns. The risk of backdoors during manufacturing poses cybersecurity threats, putting sovereignty at stake.

Government Initiatives

- **Production Linked Incentive Scheme (PLI) for Large-Scale Electronics Manufacturing:** Designed to stimulate domestic manufacturing and attract substantial investments in the electronics value chain, encompassing mobile phones, electronic components, and ATMP units, the PLI scheme offers financial incentives.
- **Modified Special Incentive Package Scheme (M-SIPS):** Initiated on July 27, 2012, M-SIPS serves to offset disabilities and entice investments in electronic manufacturing. The scheme is applicable to both new and existing projects in this sector.
- **Electronic Manufacturing Clusters (EMCs):** This program facilitates the establishment of world-class infrastructure for electronics manufacturing operations by companies, promoting a conducive environment for their growth.

Way Forward

- Leverage the government's policies and schemes such as the Production Linked Incentive (PLI), the Phased Manufacturing Programme (PMP), and the Preferential Market Access (PMA) to boost domestic manufacturing and exports of electronics products and components.
- Attract more foreign direct investment (FDI) and joint ventures from global electronics players to set up manufacturing facilities, R&D centers, and semiconductor fabs in India.

IGNITE YOUR MIND

The Ethical Electronics Dilemma: Explore the complex supply chains of electronics, including issues like resource extraction, labor conditions, and e-waste disposal, and propose solutions for more responsible production and consumption.

Semiconductor Industry in India

The semiconductor industry in India is an emerging sector that has the potential to become a global leader in the field.

- **Status:** India is a major consumer of semiconductors, with a projected domestic consumption expected to cross $ 80 billion by 2026. However, India does not have any operational semiconductor fabrication plants (fabs) and relies heavily on imports for its supply.
  - India has a strong semiconductor design talent pool, accounting for up to 20% of the world's semiconductor design engineers.
  - India also has a large and growing market for semiconductor products, especially in sectors like electronics, telecommunications, automotive, and defence.

- **Opportunities:** India has several advantages that make it a promising destination for semiconductor innovation and production.
  - These include a huge consumer base, a favourable demographic dividend, a supportive policy environment, a low-cost and skilled workforce, and a strategic location in the Asia-Pacific region.
  - India can leverage these opportunities to attract investments from domestic and foreign players, create a robust supply chain, and establish a competitive edge in the global semiconductor market.
- **Challenges:** India's pursuit of semiconductor self-reliance faces a number of challenges, such as high setup costs, technological complexities, competition from established players, technology transfer restrictions, and environmental concerns.
- **Government initiatives:** The Government of India has embarked on a concerted effort to achieve self-reliance in the semiconductor sector. Some of the key initiatives include the India Semiconductor Mission, the Production Linked Incentive (PLI) scheme for electronics manufacturing, the Modified Special Incentive Package Scheme (MSIPS), the Electronics Manufacturing Clusters (EMC) scheme, and the National Policy on Electronics (NPE).
- **Way forward:** India's semiconductor vision is ambitious and achievable, but it requires a holistic and collaborative approach. India needs to create a vibrant ecosystem of stakeholders, including the government, the industry, the academia, and the research institutions, to work together towards a common goal.

Industrial Policies at a Glance

A national industrial policy is a government's strategy to shape the development of its manufacturing and industrial sector. It involves a set of policies, regulations, and initiatives aimed at promoting investment, innovation, and competitiveness in targeted industries.

The objectives of National Industrial Policy

- Maintain a sustained growth in productivity
- Enhance gainful employment
- Achieve optimal utilisation of human resources
- Attain international competitiveness
- Transform India into a major partner and player in the global arena

Evolution of Industrial Policies in india

- Evolution of industrial policies can be summarise with help of following diagram

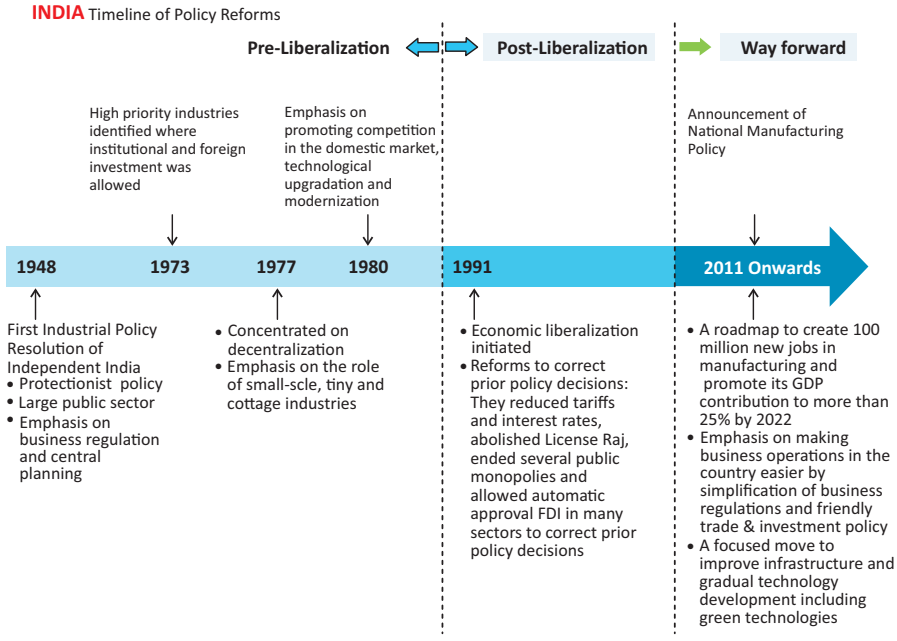

INDIA Timeline of Policy Reforms
Pre-Liberalization
Post-Liberalization
Way forward
High priority industries identified where institutional and foreign investment was allowed
Emphasis on promoting competition in the domestic market, technological upgradation and modernization
Announcement of National Manufacturing Policy
1948
1973
1977
1980
1991
2011 Onwards
First Industrial Policy Resolution of Independent India
• Protectionist policy
• Large public sector
• Emphasis on business regulation and central planning
• Concentrated on decentralization
• Emphasis on the role of small-scle, tiny and cottage industries
• Economic liberalization initiated
• Reforms to correct prior policy decisions: They reduced tariffs and interest rates, abolished License Raj, ended several public monopolies and allowed automatic approval FDI in many sectors to correct prior policy decisions
• A roadmap to create 100 million new jobs in manufacturing and promote its GDP contribution to more than 25% by 2022
• Emphasis on making business operations in the country easier by simplification of business regulations and friendly trade & investment policy
• A focused move to improve infrastructure and gradual technology development including green technologies

Fig. 9.33: Timeline of Policy Reforms in India

National Industrial Policy 2022

The National Industrial Policy 2022 is a draft document prepared by the Department for Promotion of Industry and Internal Trade (DPIIT) of India, which aims to replace the previous industrial policy of 1991. The draft policy has the following main objectives:

- To achieve **One Nation-One Standard**, which means harmonizing the quality standards of Indian products with the best international practices.
- To promote startups in every district and create startup innovation zones at the level of urban local bodies, which will foster entrepreneurship and innovation across the country.
- To incentivise Indian speciality products by creating premium international brands, which will enhance the competitiveness and value addition of Indian exports.
- To formulate a national capacity development program, which will provide skill training and certification to the industrial workforce and bridge the skill gap in various sectors.
- To encourage foreign direct investment in research and development, and create global champions in high value-added manufacturing activities.

The draft policy is still under stakeholder consultation and is expected to be finalized soon. The policy will also address the challenges faced by the micro, small and medium enterprises (MSMEs) sector, such as access to credit, technology, and markets. The policy will also align with the flagship programs of the government, such as Digital India, Make in India, and Atmanirbhar Bharat.

Make in India, 2014

The Make in India scheme is an initiative by the Government of India to boost the manufacturing sector and make India a global hub for innovation and production. The scheme was launched in 2014 with the following objectives:

- To increase the share of manufacturing in the GDP to 25% by 2025
- To create 100 million new jobs in the manufacturing sector
- To attract foreign investment and technology transfer
- To improve the ease of doing business and reduce regulatory hurdles
- To promote 25 focus sectors, ranging from aerospace and defence to tourism and hospitality
- To develop world-class infrastructure and smart cities
- To foster a culture of entrepreneurship and innovation

Make in India scheme has been implemented through various initiatives like

- Simplifying and rationalizing the FDI policy and allowing 100% FDI in several sectors
- Launching the Intellectual Property Rights Policy to protect and promote innovation
- Setting up the National Investment and Infrastructure Fund to finance infrastructure projects

Achievements of Make in India

- India jumped from 142nd to 63rd rank in the World Bank's Ease of Doing Business Index between 2014 and 2019
- India became the fifth-largest economy in the world and the second-largest manufacturer of steel in 2019
- India emerged as the third-largest startup ecosystem in the world, Since the launch of the Startup India initiative in 2016, DPIIT has recognised 98,119 entities as startups as on 30th April 2023.

Challenges

- The COVID-19 pandemic disrupted the global supply chains and demand for manufactured goods
- The domestic demand and consumption remained subdued due to the economic slowdown and lockdowns
- The infrastructure bottlenecks and logistics costs hampered the competitiveness of the manufacturing sector

Way Forward

- Improving the infrastructure and logistics: The government should invest more in developing the physical and digital infrastructure, such as roads, railways, ports, airports, power, water, internet, etc. that are essential for the smooth functioning of the manufacturing sector.
- Enhancing the skill development and education: The government should focus more on enhancing the skill development and education of the workforce, especially in the areas of science, technology, engineering, and mathematics (STEM).

Special Economic Zone (SEZ)

The SEZ policy in India underwent a transformation with the amendment of the Special Economic Zone Act in 2005. This resulted in the conversion of many Export Processing Zones (EPZs) into Special Economic Zones (SEZs).

Following the enactment of the Act, the Indian government has entertained proposals for additional, albeit smaller, SEZs. Developers are required to submit these proposals to the Indian Board of Approval, and the entire process for developing a proposed SEZ or establishing a unit within an SEZ is outlined in the SEZ Rules of 2006.

Objectives of SEZs:

- Generate additional economic activity
- Promote exports of goods and services
- Attract domestic and foreign investment
- Create employment opportunities
- Develop infrastructure facilities

Incentives for establishing a sourcing or manufacturing platform within an SEZ:

- Duty free import and domestic procurement of goods for the development, operation, and maintenance of your company/SEZ unit
- 100% Income Tax exemption on export income for SEZ units for the first 5 years, 50% for the next 5 years, and 50% of the ploughed back export profit for another 5 years
- Exemption from customs/excise duties, GST, and state levies for authorized operations
- Single window clearance for all state and federal government approvals
- Exemption in electricity duty and tax on sale of electricity by certain states in India
- Reduction of Minimum Alternate Tax (MAT) to 15 percent from 18.5 percent for SEZ units.

Types of SEZs

- **Multi-product SEZs:** Can accommodate units from various industries
- **Sector-specific SEZs:** Focus on a specific industry, such as IT, pharmaceuticals, or gems and jewellery

- **Free Trade Warehousing Zones (FTWZ):** Primarily for trading and warehousing activities

Current status of SEZs:

- These SEZs have generated approximately US$133 billion in exports.
- Service exports make up around 60% of the total exports from SEZs.
- Some of the notable SEZs in India include Kandla SEZ (Gujarat), Noida SEZ (Uttar Pradesh), Falta SEZ (West Bengal), and Visakhapatnam SEZ (Andhra Pradesh).

Challenges associated with SEZs

- **Land acquisition:** Acquiring land for SEZs has been a contentious issue, as it may involve displacement of people, loss of agricultural land, environmental concerns, and legal disputes.
- **Tax incentives:** The SEZ policy offers tax exemptions and concessions to the SEZ developers and units, which may result in revenue loss for the government and create distortions in the tax system.
- **Global competition and demand:** The SEZs in India face stiff competition from other countries that have more attractive SEZ policies and better infrastructure.
- **Linkages and spillovers:** The SEZs in India have not been able to create strong linkages and spillovers with the domestic economy, such as backward and forward linkages, technology transfer, skill development, and employment generation.

Way Forward

- The land acquisition process for SEZs should be simplified and rationalized to ensure transparency, fairness, and consent of the stakeholders.
- The tax incentives for SEZs should be revised and phased out gradually to reduce the fiscal burden and distortion.
- The infrastructure and connectivity of the SEZs should be improved and integrated with the national and regional networks.

Development of Enterprises and Services Hubs (DESH) Bill

DESH Bill is a proposed legislation that aims to enhance the scope and attractiveness of SEZs in India. The Bill intends to remove some of the restrictions and limitations that SEZs face, such as industry-specific zones, positive net foreign exchange requirement, and duty payment on domestic sales.

Some of the key features of the DESH Bill

- It will classify development hubs into two types: enterprise hubs and service hubs.
  - Enterprise hubs will allow both manufacturing and services activities, while service hubs will allow only services activities.
- It will give development hubs infrastructure status, which will enable them to access finance and borrow from lenders at easier terms.
- It will provide an online single-window portal for time-bound approvals for establishing and operating the hubs.
- It will simplify the rules for selling in the domestic market and paying duties on imported inputs and raw materials.
- It will scrap the direct tax incentives for the units operating within the hubs, making them compliant with World Trade Organization rules.

Software Technology Parks (STPs)

Software Technology Parks (STPs) are a government-driven initiative in India aimed at promoting the growth of the IT/ITES industry and fostering innovation, research and development, startups, and product development in emerging technologies. Established in 1990, STPs have played a crucial role in transforming India into a global software powerhouse.

Key objectives of STPs:

- **Boost software exports:** By providing infrastructure, tax benefits, and other incentives, STPs encourage companies to develop and export software products and services.
- **Promote IT/ITES industry growth:** STPs create a conducive environment for the IT/ITES industry to flourish by offering incubation facilities, organizing events, and facilitating networking opportunities.
- **Nurture innovation and startups:** STPs support startups and entrepreneurs through incubation centers, funding programs, and mentorship initiatives.
- **Develop emerging technologies:** STPs focus on promoting emerging technologies like artificial intelligence, blockchain, internet of things (IoT), and big data by establishing specialized centers and providing training programs.

Impact of STPs

- STPs have significantly contributed to the growth of the Indian IT/ITES industry, which is now valued at over $200 billion.
- They have created millions of jobs in the IT sector and made India a leading destination for offshore software development.
- STPs have also played a vital role in fostering innovation and entrepreneurship in the IT sector.

Current initiatives of STPs

- STPs are now focusing on promoting new technologies like artificial intelligence, blockchain, and IoT.
- They are also working on creating a more inclusive IT ecosystem by supporting startups and entrepreneurs from diverse backgrounds.
- STPs are also expanding their reach to Tier II and Tier III cities to promote regional development of the IT sector.

Fig. 9.34: India: Some software Technology Parks

IGNITE YOUR MIND

Reshoring vs. Offshoring: In an era of rising nationalism, geopolitical tensions, trade conflicts and economic uncertainty, explore the potential benefits and drawbacks of reshoring manufacturing jobs versus continued reliance on offshoring. Also, analyze the impact of these challenges on global supply chains and the location of key industries.

Industrial Corridors

- An industrial corridor is a strategically developed area within a country dedicated to industrial and manufacturing activities, aimed at boosting industrialization, economic growth, and infrastructure development.
- **Key features** of industrial corridors include infrastructure development, geographical focus, cluster development, policy support, job creation, economic growth, and sustainability. It helps in cluster development and promotes the clustering of industries, enhancing collabouration and innovation.

- Governments often provide favourable policies and incentives to attract businesses and investments to these corridors, such as tax breaks, regulatory simplifications, and trade facilitation measures. Industrial corridors also contribute significantly to a country's economic growth by promoting manufacturing, trade, and investment.

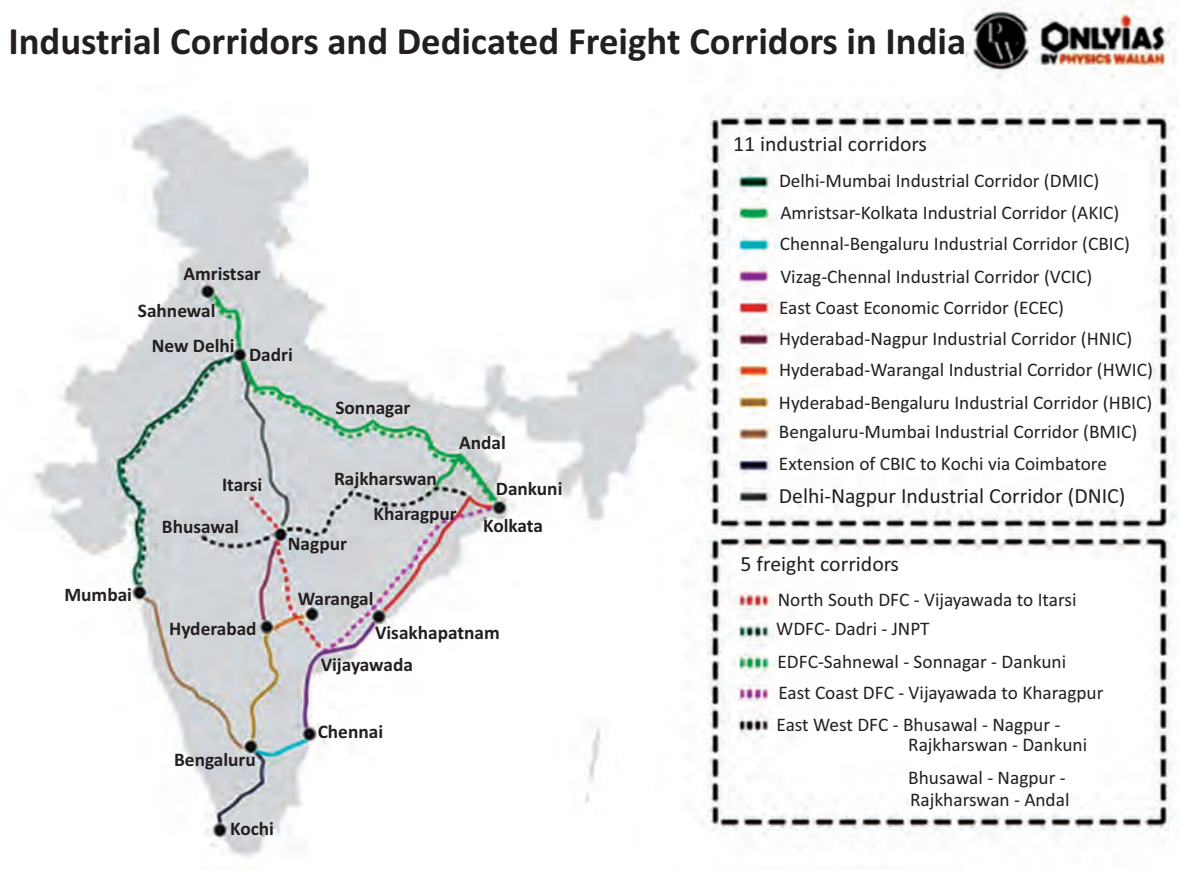


Fig. 9.35: Industrial Corridors and Dedicated Freight Corridors in India

India has undertaken **11 major industrial corridor projects** to promote economic growth, industrialization, and infrastructure development across various regions of the country which:

1. **Delhi-Mumbai Industrial Corridor**
   - The Delhi-Mumbai Industrial Corridor (DMIC) spans across the states of Uttar Pradesh, Haryana, Rajasthan, Madhya Pradesh, Gujarat, and Maharashtra.
   - Stretching over a total distance of 1483 km, the corridor connects India's political capital, Delhi, to its business hub, Mumbai.
   - With a budget of US $100 billion, the project is receiving financial support from the Government of India, Japanese loans, investments from Japanese companies, and through Japan depository receipts issued by Indian firms.
   - The primary objective of the DMIC Project is to establish advanced Industrial Cities by capitalizing on the robust "High Speed – High Capacity" connectivity provided by the Western Dedicated Freight Corridor (DFC)
2. **Amritsar-Kolkata Industrial Corridor**
   - Encompassing Punjab, Haryana, Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal, the Amritsar-Kolkata Industrial Corridor (AKIC) spans across multiple states.
   - Stretching over a distance of 1839 km, the project extends from Amritsar in Punjab to Dankuni in West Bengal.
   - The economic corridor relies on the Eastern Dedicated Freight Corridor as its essential backbone.
3. **Chennai-Bengaluru Industrial Corridor:**
   - It covers Tamil Nadu, Andhra Pradesh and Karnataka. It is being funded by the Japan International Cooperation Agency (JICA).
4. **Vizag-Chennai Industrial Corridor**
   - Marking a significant milestone, it stands as the nation's inaugural coastal economic corridor.
   - Encompassing over 800 km of Andhra Pradesh's coastline, the corridor is strategically aligned with the Golden Quadrilateral.
   - Integral to India's "Act East Policy," it plays a pivotal role in fostering economic connections and development.
   - In September 2016, the Asian Development Bank (ADB) granted approvals for loans and grants totaling US$ 631 million dedicated to the infrastructure development along the VCIC.

5. **Bengaluru-Mumbai Industrial Corridor**
   - Encompassing Maharashtra and Karnataka, the Bengaluru-Mumbai Economic Corridor (BMEC) spans across two Indian states.
   - The development of this corridor is underway with the assistance of the United Kingdom (UK).
   - On the Indian side, the Delhi Mumbai Industrial Corridor Development Corporation (DMICD) and on the UK side, the UK Trade and Investment (UKTI) have been designated as the respective nodal agencies determined to oversee the project.
6. **Odisha Economic Corridor:**
   - Odisha Economic Corridor is part of the northernmost stretch of the East Coast Industrial Corridor (ECIC)
   - It comprises of 11 industrial clusters spanning approx. 600 km along the National Highway 16, with a total project area of 11366 acres of land. They are classified into two zones namely, Gopalpur-Bhubaneswar- Kalinganagar Zone and Paradip-Kendrapada- Dhamra- Subernarekha zones.
7. **Hyderabad Nagpur Industrial Corridor:**
   - The Hyderabad-Nagpur Industrial Corridor (HNIC) is a 585 km stretch that connects Hyderabad and Nagpur. The corridor is located about 9 km north of Zaheerabad, a major commercial center.
   - The HNIC aims to explore the central location of Nagpur, which is proposed as a multi-modal international cargo hub. The corridor will bring about multifaceted development between Hyderabad and Nagpur through rail, road, and airways.
8. **Hyderabad Warangal Industrial Corridor:**
   - The Hyderabad Warangal Industrial Corridor (HWIC) is a 235 km corridor that runs along NH 163 between Hyderabad and Warangal. The two cities are two of the most important economic hubs in the state of Telangana.
9. **Hyderabad Bengaluru Industrial Corridor:**
   - The Hyderabad Bengaluru Industrial Corridor (HBIC) is an industrial corridor being developed between the two IT centers of India, Hyderabad and Bengaluru.
   - The HBIC will have an influence area across three states: Telangana, Andhra Pradesh, and Karnataka. The HBIC includes an industrial node covering Anantapur, Hindupur, and Orvakal.
10. **Extension of CBIC to Kochi via Coimbatore:**
    - The Chennai Bengaluru Industrial Corridor (CBIC) is being extended to Kochi via Coimbatore.
    - The extension covers parts of Tamil Nadu and Kerala. The extension was approved by the National Industrial Corridors and Implementation Trust (NICDIT)
11. **Delhi Nagpur Industrial Corridor:**
    - The Delhi-Nagpur Industrial Corridor (DNIC) is a project that connects North and South India.
    - The DNIC will pass through Bhopal, and 70% of the project will be in Madhya Pradesh. The DNIC will also have an influence area across the states of Delhi, Uttar Pradesh, and Rajasthan.

Defence Industrial Corridors

The Government of India has established two Defence Industrial Corridors (DICs) to boost the defence manufacturing sector with an aim to attract a total investment of Rs 20,000 crore by 2024-25.. The primary objectives include attracting investments, developing the domestic supply chain, and strengthening the defence manufacturing ecosystem in the country.

1. The **Uttar Pradesh Defence Industrial Corridor (UPDIC)** encompasses six nodes: Aligarh, Agra, Jhansi, Kanpur, Chitrakoot, and Lucknow.
   - **Nodal agency:** Uttar Pradesh Expressways Industrial Development Authority (UPEIDA).
2. The **Tamil Nadu Defence Industrial Corridor (TNDIC)** consists of five nodes: Chennai, Hosur, Coimbatore, Salem, and Tiruchirappalli.
   - **Nodal agency:** Tamil Nadu Industrial Development Corporation (TIDCO).

Significance of Industrial Corridors in India

- **Economic diversification and competitiveness**: Industrial corridors promote specialized sectors like manufacturing, agro-processing, textiles, pharmaceuticals, and IT, utilizing local resources. This drives economic diversity, competitiveness, and fosters job creation and skill development.
  - For example, the Chennai Bengaluru Industrial Corridor (CBIC) focuses on sectors such as automobiles, aerospace, electronics, and biotechnology, leveraging the existing industrial clusters and innovation hubs in the region.
- **Sustainable urbanization and smart city development**: Industrial corridors offer comprehensive solutions for housing, transportation, energy, water, waste management, and social amenities like education and health. This promotes sustainable urbanization, smart city development, and enhances environmental protection and quality of life.
  - For example, the DMIC project envisages the development of 24 smart cities along the corridor, with features such as green buildings, renewable energy, intelligent transport systems, and e-governance.
- **Trade and investment prospects**: Industrial corridors boost connectivity, access to markets, and attract foreign and domestic investment, enhancing India's trade, investment prospects, and global economic integration.
  - For example, the East Coast Industrial Corridor (ECIC) with Vizag Chennai Industrial Corridor (VCIC) as Phase 1, will leverage the strategic location of the eastern coast of India and its proximity to the Southeast and East Asian markets.

Geographical Distribution of Major Industrial Regions in the World

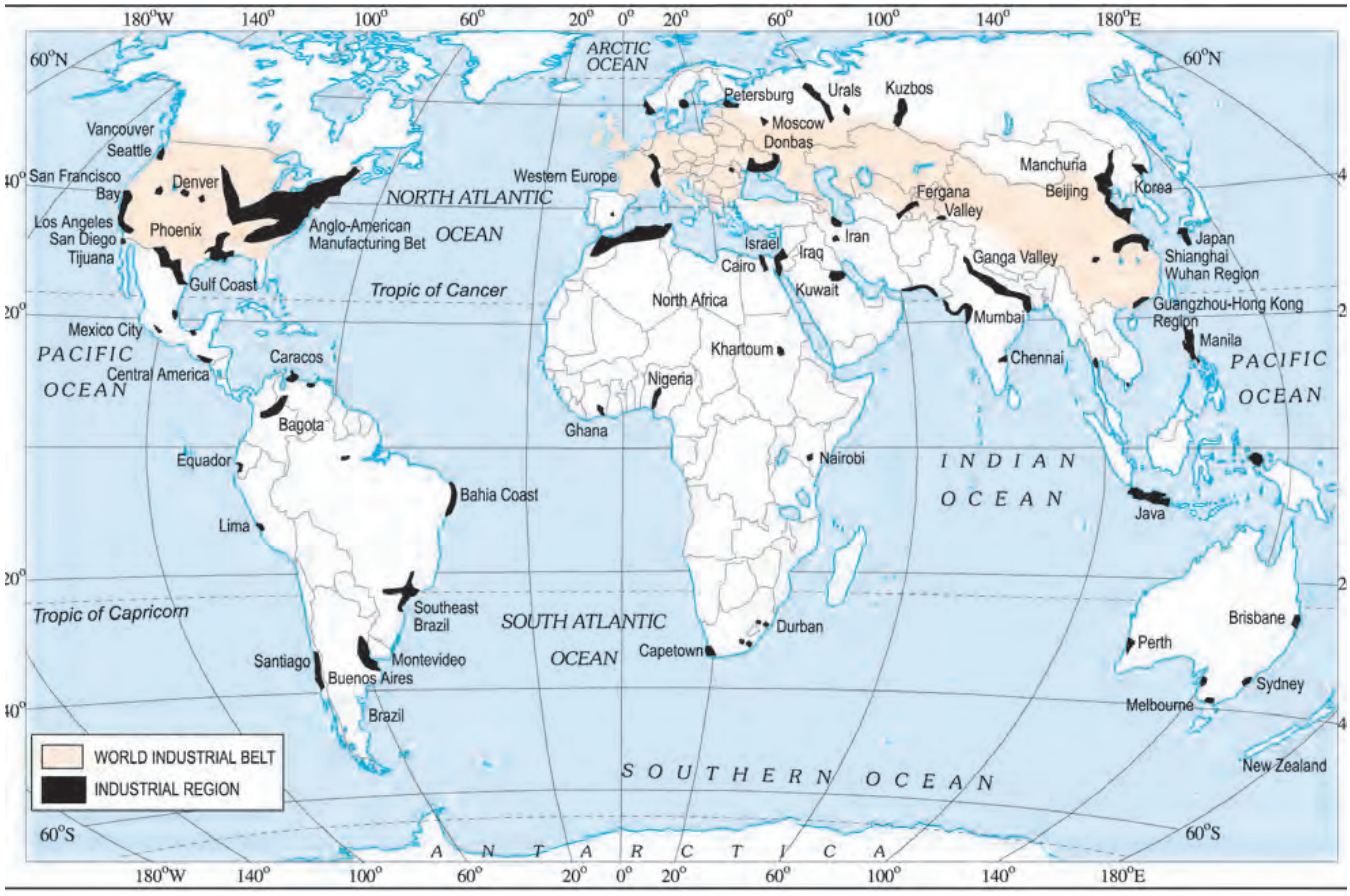


Fig. 9.36: Major Industrial Belts and Regions of the World

- **North American region**, comprising the USA and Canada. This region is the largest and most diversified industrial region in the world, with a strong presence of manufacturing, service, and high-tech industries.
  - The region is well-connected by a network of highways, railways, waterways, and pipelines, and has abundant natural resources such as coal, oil, natural gas, iron ore, and timber.
  - Some of the major industrial centers in this region are New York, Chicago, Detroit, Los Angeles, Toronto, and Montreal.
- **European region**, consisting of the industrial regions of the UK, Germany, France, Italy, Belgium, the Netherlands, and Switzerland. This region is the second-largest industrial region in the world, and has a long history of industrialization, innovation, and trade.
  - The region is known for its high-quality products, such as automobiles, machinery, chemicals, textiles, and consumer goods.
  - The region also has a well-developed infrastructure, a skilled workforce, and a large domestic and international market. Some of the major industrial centers in this region are London, Paris, Berlin, Frankfurt, Milan, Brussels, and Zurich.
- **Asian region**, comprising the industrial regions of Japan, China, India, South Korea, and Taiwan. This region is the fastest-growing industrial region in the world, and has emerged as a major competitor to the North American and European regions.
  - The region is characterized by a large and diverse population, a dynamic and entrepreneurial culture, and a rapid adoption of new technologies.
  - The region also has a rich endowment of natural resources, such as coal, oil, iron ore, and hydroelectric power.
  - Some of the major industrial centers in this region are Tokyo, Shanghai, Mumbai, Seoul, Taipei, and Bangalore.
- **Russian region**, consisting of the industrial regions of Moscow, St. Petersburg, Volga, Ural, and Siberia. This region is the largest industrial region in terms of area, and has a significant potential for further development.
  - The region is endowed with vast natural resources, such as oil, gas, coal, iron ore, and timber, and has a strong industrial base, especially in heavy industries, such as steel, machinery, chemicals, and military equipment.
  - The region also has a strategic location, connecting Europe and Asia, and a large domestic market.
  - Some of the major industrial centers in this region are Moscow, St. Petersburg, Nizhny Novgorod, Yekaterinburg, and Novosibirsk.

- **Other industrial regions**, including the industrial regions of Brazil, South Africa, Australia, and Mexico. These regions are relatively smaller and less developed than the above-mentioned regions, but have shown significant growth and diversification in recent years.
  - These regions have benefited from their abundant natural resources, such as iron ore, copper, gold, and oil, and their proximity to large and emerging markets, such as the USA, China, and India.
  - Some of the major industrial centers in these regions are Sao Paulo, Johannesburg, Sydney, and Mexico City.

Geographical Distribution of Major Industrial Regions in India

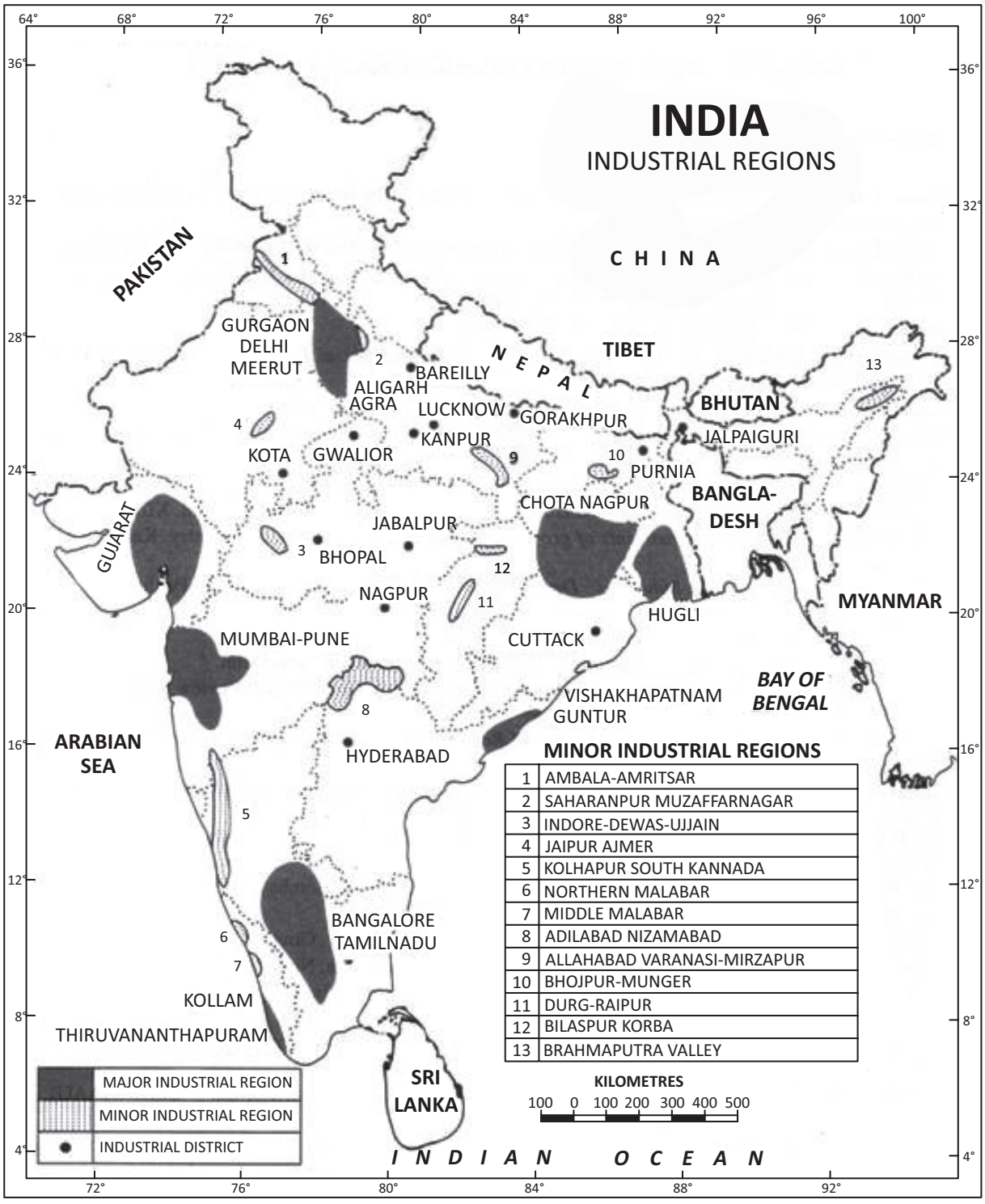


Fig. 9.37: Major & Minor Industrial Regions of India

Mumbai-Pune Industrial Region

- The preeminent industrial region in the country emerged following the British arrival in India, particularly with the development of the Mumbai seaport.
- After the inauguration of the **Suez Canal** in 1869, the sea route connecting India and Europe was significantly shortened.
- The growth of this industrial region is intricately tied to the history of the cotton textile industry in India.
- Factors such as a humid climate, natural port facilities, access to hydro-power, skilled labour, and an extensive hinterland producing cotton played crucial roles in the development of this industrial region.
- In the greater Mumbai area alone, there are more than 8000 registered factories, with 350 dedicated to the cotton textile industry.
- Other industries in the region include engineering goods, chemical industries, food processing, leather goods, pharmaceuticals, and film production.
- Mumbai primarily produces light-textured, fine, and super-fine cotton fabrics.
- Pune stands as the second most significant industrial center, boasting over 1200 registered factories specializing in metallurgical, chemical, engineering, and automobile goods.
- Beyond Mumbai and Pune, the industrial centers in this region include Ambarnath, Andheri, Bhandup, Ghatkopar, Hadapsar, Jogeshwari, Kalyan, Kirkee, Kolhapur, Kurla

Hugli Industrial Region

- The industrial region along the banks of the Hugli River, known as the **Kolkata-Hugli industrial region**, is situated adjacent to the Hugli River.
- In the west, industries have also flourished in the Midnapur district. The Hugli River provided an ideal location for establishing an inland river port, serving as the focal point for the development of the Hugli industrial region.
- The rapid growth of this industrial region can be attributed to several factors, including the availability of agro-raw materials such as jute, indigo, and tea, proximity to coal mines in **Raniganj and Jharia,** ample water resources, affordable labour, and export facilities.
- Additionally, Kolkata served as the capital of British India from 1773 to 1911. This status attracted numerous industrialists to establish their industries in the region.
- The **Hugli** industrial region boasts over thousands of registered industrial factories, engaging more than 20 lakh people.
- Key industrial cities and towns in this region include Naihati, Bhatpara, Shamnagar, Krishnanagar, Serampore, Titagarh, Rishra, Kolkata, Haora, and Budge.

Bangalore-Tamil Nadu Industrial Region

- Encompassing the state of Tamil Nadu and the southern regions of Karnataka, this holds significant importance as an industrial center that witnessed substantial progress post-independence.
- Primarily recognized as the main cotton-producing area in the country, this region benefits from favorable climatic conditions, a disciplined workforce with both skilled and unskilled labour, a consistent power supply from **Mettur, Papanasam, Pykara, Savitri, and Sivasamudram, and the proximity of Chennai, Kochi, Mangalore, and Tuticorin seaports**. These factors have collectively accelerated the rapid development of this industrial region.
- The workforce distribution in this region reveals that approximately 60% of employees are involved in the textile industry, followed by 18% in engineering and around 12% in food processing.

Gujarat Industrial Region

- Ranking as the third-largest industrial region in the country, the development of this region is primarily attributed to factors such as the availability of cotton in the hinterland, inexpensive land, cost-effective skilled and unskilled labour, port facilities, and the proximity of petroleum, thermal, hydel (Ukai project), and nuclear power stations (Kakrapara).
- As per Director Industrial Safety and Health, total number of registered factories are 47762, as on January 2024, this region stands as the second-largest cotton textile industrial center in the country. It also specializes in chemical industries, engineering goods, and pharmaceutical products.
- **Vadodra** plays a crucial role as an important center for woollen textiles and petrochemical goods, while Surat is renowned for silk textiles and diamond cutting. Other significant industrial centers in this region include Anand, Ankleshwar, Bhavanagar, Bharuch, Godhra, Jamnagar, Kalol, Kheda, Rajkot, and Surendernagar.

Chotanagpur Industrial Region

- This industrial region encompasses Jharkhand, Odisha, Southern Bihar, and the western parts of West Bengal, is widely recognized for its substantial concentration of the iron and steel industry, often referred to as the **'Ruhr of India.'** Abundant in fossil fuels and metallic and non-metallic minerals, the region benefits from power supplied by the **Damodar Valley Corporation,** and it has access to a large pool of affordable labour from states such as Bihar, Jharkhand, Odisha, Uttar Pradesh, and West Bengal.
- As the primary centers for iron and steel production in the region, Asansol, Bokaro, Burnpur, Durgapur, Kulti, Jamshedpur, and Raurkela play pivotal roles. Other noteworthy industrial centers include Sindri for fertilizer

production, Chittranjan for locomotives, Ranchi for HMT, and Ramgarh and Bhurkunda for the glass industry.

Vishakhapatnam-Guntur Industrial Region

- Spanning from the Vishakhapatnam district to the southern districts of Kurnool and Prakasam, this industrial region relies on the ports of Vishakhapatnam and Machilipatnam, as well as the developed agriculture and abundant mineral reserves in their hinterlands.
- Energy for the region is provided by the coalfields in the Godavari basin. The shipbuilding industry, initiated in Vishakhapatnam in 1941, and petroleum refineries, relying on imported petroleum, have facilitated the growth of numerous petrochemical industries.
- The primary industries in this region include sugar, textiles, jute, paper, fertilizer, cement, aluminum, and light engineering. Key industrial centers encompass Vishakhapatnam, Vijayawada, Vijaynagar, Rajahmundry, Guntur, Eluru, and Kurnool.

Gurgaon-Delhi-Meerut Industrial Region

- This region is far away from mineral and energy resources, and the industries in this location are characterized by their small scale and a focus on meeting local market demands.
- The key industries in the region encompass electronics, light engineering, and electrical items. Additionally, there are substantial enterprises engaged in the production of cotton, woolen, and synthetic textiles, hosiery, sugar, cement, machine tools, tractors, bikes, agricultural equipment, chemicals, and vanaspati.
- The software sector is a relatively recent addition to the industrial landscape. The Agra-Mathura industrial sector, specializing in glass and leather items, is situated to the south, with Mathura serving as a petrochemical complex due to its oil refinery.
- Mentioned among the industrial cities in this region are Gurgaon, Delhi, Shahdara, Faridabad, Meerut, Modinagar, Ghaziabad, Ambala, Agra, and Mathura.

Kollam-Thiruvananthapuram Industrial Region

- It encompasses the districts of **Thiruvananthapuram, Kollam, Alwaye, Ernakulam, and Alappuzha,** this industrial zone forms a crucial economic hub.
- The industrial foundation of this region is rooted in plantation agriculture and hydropower, with a focus on agricultural goods processing and market-oriented light industries.
- Situated away from the country's mineral belt, this region is a key player in the production of significant items such as cotton textiles, sugar, rubber, matchboxes, glass, chemical fertilizers, and fish-based businesses.
- Important industries in the area include food processing, paper, coconut coir products, aluminum, and cement, contributing to the overall economic significance of the region.
- Key industrial centers in this zone comprise Kollam, Thiruvananthapuram, Alwaye, Kochi, Alappuzha, and Punalur.

Advantages of Industrial Sector

- Industrial sector boosts GDP and economic prosperity by creating diverse employment opportunities, reducing unemployment rates.
- Manufacturing fosters innovation, technological advancement, and exports, contributing to a favorable trade balance.
- Regional development is promoted as manufacturing facilities are distributed, reducing economic disparities.
- Manufacturing adds value to raw materials, enhancing a nation's income and wealth.
- The sector is actively improving sustainability practices amid growing environmental concerns.
- Industrialization drives research and development, leading to progress in various fields like atomic science and communication technology.
- Industrial development drives faster growth in national and per capita income by efficiently utilizing resources, training unskilled workers, and contributing to urbanization. In India, industrialization has significantly reduced poverty, lifting around 25 crore people out of impoverished conditions.

Challenges Faced by the Industrial Sector

Global Challenges

- **Competition from low-cost producers:** China and other countries have become key manufacturing hubs, providing affordable labour, raw materials, and technology. This compels industrial sectors worldwide to cut costs and enhance quality.
- **Workforce Transformation:** The need for a highly skilled and adaptable workforce is increasing due to automation and the integration of advanced technologies, requiring continuous training and upskilling.
- **Trade barriers and uncertainties:** The industrial sector relies heavily on global trade, but faces challenges like protectionism, tariffs, sanctions, and geopolitical conflicts, leading to uncertainties and risks.
- **Supply Chain Disruptions:** Global industries are interconnected, and disruptions in one part of the world can have a cascading effect on supply chains globally.

Indian Challenges

- **Lack of infrastructure and skilled manpower:** The industrial sector in India suffers from inadequate and inefficient infrastructure, such as power, transport, and communication.

- **Complex and rigid regulations:** The industrial sector in India has to deal with a complex and rigid regulatory framework, which involves multiple laws, rules, and procedures.
- **Access to Finance:** Many small and medium-sized enterprises (SMEs) in India face challenges in accessing affordable and timely finance, limiting their growth potential.
- **Land Acquisition and Legal Issues:** Land acquisition for industrial projects can be a lengthy and complex process, often entangled in legal challenges and community resistance.

Industrial pollution and environmental degradation

- **Air pollution:** Industries release many harmful gases and particles into the air, such as carbon dioxide, sulphur dioxide, carbon monoxide, dust, smoke, etc. These pollutants affect the health of humans and animals, and also contribute to global warming and climate change.
- **Water pollution:** Industries discharge their untreated or partially treated wastewater and effluents into rivers, lakes, and oceans, causing contamination of water resources. The pollutants include dyes, detergents, acids, salts, heavy metals, pesticides, fertilizers, plastics, etc.
- **Land pollution:** Industries extract a lot of raw materials from the ground, such as minerals, metals, coal, oil, etc. This leads to soil erosion, loss of fertility, and degradation of land. Industries also generate a lot of solid waste, such as fly ash, slag, gypsum, etc.
- **Thermal pollution:** Industries use a lot of water for cooling purposes, and then release the hot water back into the water bodies. This increases the temperature of the water, affecting the dissolved oxygen levels and the metabolism of the aquatic organisms.

Control of Environmental Degradation

- **Environmental Legislation and Regulations:** The Ministry of Environment, Forest and Climate Change (MoEFCC) in India formulates and enforces environmental regulations. The Environment Protection Act (1986) and the Water (Prevention and Control of Pollution) Act (1974) are among the key legislations.
- **Environmental Impact Assessment (EIA):** Industries, particularly those falling under the Category 'A' and 'B' in the Schedule of the EIA Notification, are required to undergo a detailed Environmental Impact Assessment before getting environmental clearance.
- **Corporate Social Responsibility (CSR):** The Companies Act, 2013 mandates that certain companies allocate a portion of their profits towards corporate social responsibility activities, which may include environmental conservation initiatives.
- **Carbon Credits and Trading:** India has implemented carbon credit mechanisms which should be promoted to encourage industries to reduce their carbon footprint.
- **Carbon Capture and Utilization (CCU):** Invest in research and development of carbon capture technologies that can capture and utilize carbon emissions from industrial processes, turning them into valuable products or storing them safely.

IGNITE YOUR MIND

The Gig Economy's Double-Edged Sword: Examine the growing gig economy in various industries, considering its flexibility and potential pitfalls regarding worker rights, social security, and job security.

SDG 9 and India: Building Resilient Infrastructure and Sustainable Industrialization

SDG 9 states that "Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation."

- **India's Commitment to SDG 9:** India is actively working towards the implementation of SDG 9 and has shown significant progress.

Achievements and Initiatives:

- **National Highways and Roads Development:**
  - **Growth:** Length of 4 lanes and above NH increased by 2.5 times – 18,387 km (2014) to 46,179 km (Nov'23).
- **Industrial Corridor Project:**
  - **Scope:** An ambitious project with an estimated expenditure of **US$90 billion**.
  - **Impact:** Expected to become a thriving hub for trade and commerce, spanning six states and creating smart cities, industrial parks, and logistics hubs.
- **Renewable Energy Adoption:**
  - **Increase:** India's installed non-fossil fuel capacity has increased 396% in the last 8.5 years and stands at more than 179.57 GW (including large Hydro and nuclear), about 42% of the country's total capacity (as of November 2023). India saw the highest year-on-year growth in renewable energy additions of 9.83% in 2022. Renewable Energy in India.
  - **Milestone:** Achieved **100% household electrification** under the Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA) scheme.

Challenges Faced by India in Achieving SDG 9

- **Inadequate Infrastructure:**
  - **Impact:** Hampers connectivity, productivity, and access to basic services, particularly in rural areas.

- **Low Industrial Diversification:**
  - **Limitation:** Low level of industrial diversification and value addition.
  - **Implications:** Limits job creation, income growth, and export competitiveness.
- **Insufficient Investment in Innovation:**
  - **Impact:** Affects the development of new solutions and technologies for sustainable development.

Initiatives to Address Challenges:

- **National Infrastructure Pipeline:**
  - **Objective:** Aims to invest **111 trillion rupees (about 1.5 trillion US dollars)** in infrastructure projects across various sectors by 2025.
- **Make in India Campaign:**
  - **Goals:** Boost the manufacturing sector by improving the ease of doing business, attracting foreign direct investment, and promoting innovation and quality standards.

It's crucial for countries to strike a balance between industrial development and environmental sustainability. Continued efforts to implement and strengthen regulations, invest in cleaner technologies, and promote sustainable practices are essential to achieving the goals outlined in SDG 9 while minimising the negative impact on the environment.

Making India as the Manufacturing Hub

India has been actively pursuing the goal of becoming a global manufacturing hub for several years now, with initiatives like "Make in India" and "Atmanirbhar Bharat" aiming to boost the sector's contribution to the economy and create jobs. While there's been progress, there are still challenges to overcome.

Progress made

- **Increased manufacturing output:** India's manufacturing sector has grown steadily in recent years, contributing around 17 percent of GDP in 2023. It's now among the top 3 most sought-after manufacturing destinations globally.
- **Government initiatives:** Schemes like PLI (Production Linked Incentive) offer financial support to specific industries, attracting investments and promoting domestic production.
- **Skilling programs:** Initiatives like Skill India aim to bridge the skill gap in the workforce, preparing individuals for manufacturing jobs.

Challenges

- **Infrastructure bottlenecks:** Inadequate logistics, power supply, and transportation networks pose hurdles for smooth operations and timely delivery.
- **Bureaucracy and regulations:** Navigating complex regulations and obtaining approvals can be time-consuming and costly for businesses.
- **Global competition:** Other countries like China and Vietnam offer competitive advantages, requiring India to constantly improve its offerings.
- **Skilled Workforce:** In India, only 4.69% of the workforce possesses formal skills, contrasting with 24% in China, 75% in Germany, and 96% in South Korea.

Way Forward

- **Focus on high-value manufacturing:** Moving beyond basic goods towards sectors like electronics, pharmaceuticals, and advanced machinery.
- **Streamlining regulations:** Simplifying procedures and reducing bureaucratic hurdles for businesses.
- **Upskilling the workforce:** Equipping individuals with industry-relevant skills through targeted training programs.

IGNITE YOUR MIND

Industry 4.0 and Beyond: Imagine the potential disruptions and opportunities arising from artificial intelligence, automation, and other future technologies in various industries. How can we prepare for and shape this transformation responsibly?

CONCLUSION

Industries are not just engines of economic growth; they are the cornerstones of our societies, shaping our lives in profound ways. Industries continue to evolve, adapting to technological, societal, and environmental changes. The future promises exciting developments, with industries at the forefront of innovation, sustainability, and human progress. As we navigate the complexities of the global economy, industries will play a crucial role in shaping the world we inhabit.

Transport, Communication and Trade

10

Everyday essentials like toothpaste, food, and clothing journey from production sites to markets through a vital transportation network. This system is not just a logistical link but also a key factor in ensuring the availability of goods for consumers. Efficient transport is crucial, as it bridges the gap between production and consumption, enabling goods to reach us seamlessly. The importance of transport in the economy is highlighted by its role in facilitating access to necessities, underscoring its significance in our daily lives.

MEANS OF TRANSPORTATION

The utilization of transportation and communication rely on our requirement to transfer objects from their availability location to their usage location. Humans transport things, commodities, and ideas through a variety of techniques.

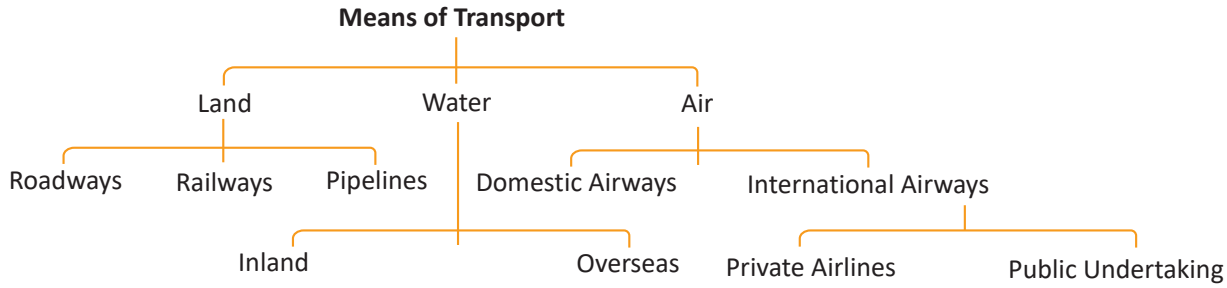


Fig. 10.1: Means of Transport

LAND TRANSPORT

Globally, the evolution of land transport has followed a similar trajectory. Historically, nations initially relied on footpaths and rudimentary roads. As technology advanced and economies grew, there was a widespread shift towards the development of metalled roads and railroads.

This transition occurred not only in India but also around the world. The construction of more sophisticated transportation infrastructure became imperative to efficiently move substantial quantities of goods and people across various regions. The global perspective underscores the commonality in the progression of land transport, showcasing its integral role in societal and economic advancements across diverse nations throughout history.

Global Road Network: Only around 15 million km of the world's motorable road network are in North America, which makes up about 33% of that total. North America has the most registered car population and the greatest road density (number of road miles per square metre). Road traffic can have peaks (high points) and troughs (low points) during certain periods of the day, with maxima occurring before and after work rush hour. Congestion is a major issue in the majority of global cities.

Global Transcontinental Highways : Key Arteries of International Connectivity

Transcontinental highways are monumental in linking diverse regions across continents, playing a crucial role in international trade, travel, and cultural exchange. Here are some of the world's most important transcontinental highways

- **Pan-American Highway:** 30,000 km, Alaska to Argentina.
- **Trans-African Highway:** 56,683 km network in Africa.
- **Asian Highway Network (AHN):** 145,000 km, Asia to Europe.
- **European Route E30:** Cork, Ireland to Omsk, Russia.
- **Trans-Canada Highway:** 7,821 km, Victoria to St. John's.

Road Transport In India

India boasts a vast road network spanning approximately 66.71 lakh kilometers, making it the **second-largest globally.** The distribution of road types is as follows:

- National Highways: 1,46,145 km
- State Highways: 1,79,535 km
- Other Roads: 63,45,403 km

National Highways are crucial for the country's economic and social growth, facilitating the smooth transit of goods and passengers and enhancing market accessibility. Over the past eight years, the Ministry of Road Transport and Highways (MoRTH) along with its affiliates has undertaken

numerous projects to expand and upgrade the infrastructure of National Highways.

As of January 5, 2024, the total extent of National Highways in India reached 1,46,145 kilometers.

- In India, the northern plains, where building roads is relatively simple, are home to the country's densest road network. Building roads in hilly areas is pretty challenging. Jammu & Kashmir has the lowest road density, whereas Kerala has the most.

Do You Know?

The Shahi (Royal) route was constructed by Sher Shah Suri to expand and reinforce his Bengali Sonar Valley dominion from the Indus Valley. The Grand Trunk (GT) route, which connects Kolkata and Peshawar, was given a new name during the British era. It now stretches from Kolkata to Amritsar.

Classification of Roads In India

The classification of roads in India is based on several criteria, allowing for systematic planning, development, and maintenance of the road network. The primary criteria for the classification of roads in India is Control and Management:

a. **National Highways (NH):** Managed by the Central government, connecting major cities, ports, capitals, and strategic locations.

b. **State Highways (SH)**: Managed by State governments, linking district headquarters and important towns within the state.

c. **District Roads:**
   - Major District Roads (MDR): Managed by district authorities, providing connectivity within the district, often linking district headquarters and block levels.
   - Other District Roads (ODR): Also managed by district authorities, connecting rural areas and villages.

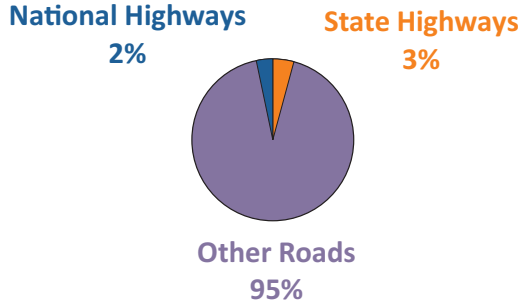


Fig. 10.2: Road Network India

National Highways

- The National Highways are the main roads which are built and maintained by the Central Government. These routes are used for inter-state transportation as well as the mobility of defense personnel and materiel in key locations.
- These also link state capitals, large cities, vital ports, railway connections, and so on. As of January 2023, the total length of National Highways in the country was **1,46,145 km**.

Do You Know?

1995 marked the establishment of the **National Highways Authority of India (NHAI).** It is a statutory body reporting to the **Ministry of Surface Transportation.** The Government of India has entrusted it with the responsibility of developing, maintaining, and managing the National Highways.

- **The Ministry of Road Transport and Highways** of India is responsible for the construction and upkeep of India's national highways.
- The **longest national highway is NH-44,** which stretches 3745 km from Srinagar in Jammu and Kashmir to Kanyakumari in Tamil Nadu. The **shortest national highway is NH-47A**, which stretches from Ernakulam to Kochi port (Willington Island).
- National Highways (NHs) in India constitute approximately **2.7% of the total road length**.The total length of National Highways in India is around 150,000 kilometers.
- National Highways cater to 45 percent of the total transport demand.

Bharatmala Pariyojana

- The Bharatmala Pariyojana was initiated with the main objective of enhancing the efficiency of transport for the movement of goods and people across the nation.
- **Phase I of the Bharatmala Pariyojana**, which was launched in October 2017, is primarily concerned with addressing significant deficiencies in infrastructure by means of **constructing 34,800 km of national highways.**
- The Pariyojana placed significant emphasis on the implementation of a "**corridor-based national highway development**" strategy with the aim of achieving infrastructural symmetry and ensuring a uniform road user experience.
- The original route of NH 7, which is now NH 44, is the longest national highway in India. It traverses the Union Territories from Srinagar, Jammu and Kashmir, to the southernmost point of Kanyakumari, Tamil Nadu. The total distance traveled on NH 44 is 3,745 kilometers.

Golden Quadrilateral (GQ)

- **Length:** 5,846 km.
- **Lanes:** 4/6 lanes, facilitating high-speed travel.
- **Connectivity:** Links India's four major metropolitan cities - **Delhi, Kolkata, Chennai, and Mumbai, forming a quadrilateral.**
- **Launch Year:** 1999.

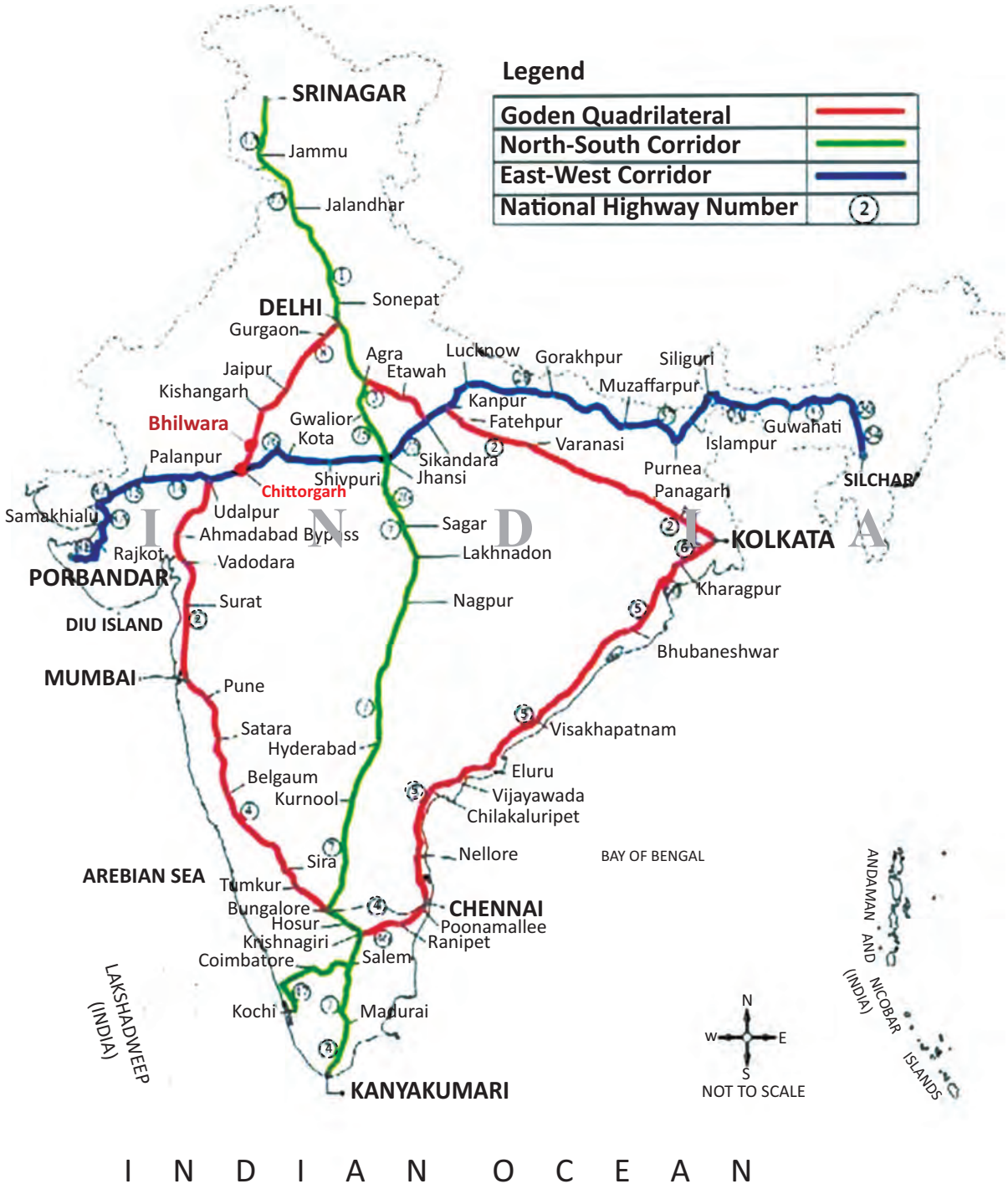


Fig. 10.3: Golden Quadrilateral (GQ) and North-South and East-West Corridors

- **Objective:** To improve road connectivity and efficiency in transportation across major cities, boost economic development, and reduce travel times.
- **Impact:** Facilitates smoother and faster movement of goods and people, significantly contributing to the economic integration of the country.

North-South and East-West Corridors:

- **Length:** North-South Corridor is 4,076 km long.
- **Connectivity:** North-South Corridor aims to connect Srinagar (Jammu and Kashmir) in the north to Kanyakumari (Tamil Nadu) in the south, including a spur from Kochi to Salem.
- **Objective:** To enhance connectivity between the northern and southern parts of India, promoting regional development and reducing transportation times.
- **Significance:** These corridors, along with the Golden Quadrilateral, form a key part of India's strategy to improve its highway network for better national connectivity, facilitating trade and fostering economic growth.

Road Development Program for North East Region

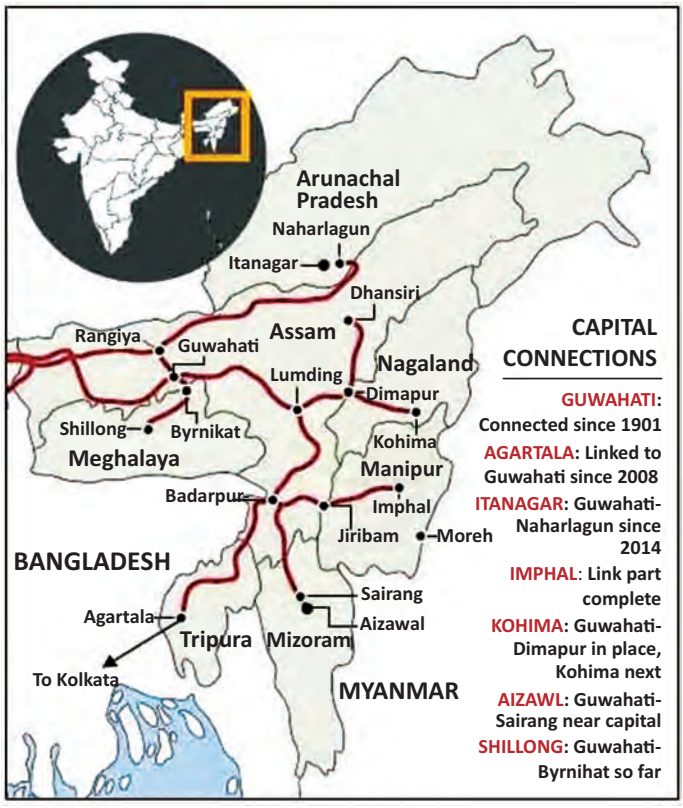


Fig. 10.4: Road Development Program for North East Region

- **The Special Accelerated Road Development Programme for the North-Eastern region (SARDP-NE)** focuses on enhancing road connectivity between remote areas in the North East and major centres like state capitals and district headquarters.
- **SARDP-NE's** objective is improvement of connectivity and road infrastructure of a length of about 6418 km. This initiative aims to link district headquarters in the North Eastern states to the nearest National Highways, significantly improving overall regional connectivity.

State Highways

- State Highways are roads that connect a state capital to several district headquarters. These are constructed and maintained by state governments. These routes connect to interstate highways. These represent **4% of the total road length in the nation.**
- The total length of state highways is 1,86,908 km in 2022. **Kerala has the highest road density (375 km) while Jammu and Kashmir has the lowest (just 10 km).** Kerala has the highest road density in India, followed by Tripura. Kerala has a road network of 5,268.69 km per 1,000 square kilometers.

District Roads

- These highways provide a connection between the District and the district's other important routes. They account for **roughly 14% of the total length of roads** in the country. There are approximately 632,154 kilometres of district roads in India (2022).

Rural Roads

These routes are essential for linking rural areas. **Approximately 80% of India's road length consists of rural roads.** The density of rural roads differs by region due to the influence of terrain type. Rural Roads (including JRY roads) constitute 71.4 % of total road network in the country and its length rose to 45, 22,228 km on 31 st March, 2019 registering a growth of 2.5 % over previous year.

- **Pradhan Mantri Gram Sadak Yojana (PMGSY):** Launched on December 25, 2000, It is a centrally sponsored scheme aiming to provide all-weather road access to India's remote communities. Eligible areas include plains with 500+ population and hilly, tribal, desert, and backward regions with 250+ population. Currently in its third phase.

Border Roads

These are the highways that are strategically important in border areas. **Border Roads Organization** constructs and maintains them. Established in 1960, its initial aim was to make way for significant transportation connections between northern and northeastern border regions.

- **BRO initiatives:** Atal Tunnel (Manali-Leh Road) and Umling La Pass Road (world's highest motorable road in Ladakh) for border region connectivity.
- **Projects:** Himank and Arunank focus on Ladakh and Arunachal Pradesh roads.
- **Infrastructure:** Ladakh and North-East roads, bridges, and tunnels development.

Expressways

- These are multi-lane, high-quality highways designed for high-speed traffic. The following expressways are important: The Yamuna Expressway from Delhi to Agra, the Mumbai-Pune Road, the Kolkata-Dumdum Airport Road, the Samruddhi Mahamarg Nagpur-Mumbai Expressway, the Durgapur-Kolkata Road, etc.
- **Existing Expressways:** Delhi Meerut Expressway: 96 km (Delhi, Uttar Pradesh); Agra Lucknow Expressway: 302 km (Uttar Pradesh); Yamuna Expressway: 188 km (Uttar Pradesh); Eastern Peripheral Expressway: 135 km (Haryana, Uttar Pradesh); Mumbai Pune Expressway: 94.5 km (Maharashtra); Ahmedabad Vadodara Expressway: 140.23 km (Gujarat)
- **Under Construction:** Chennai Bengaluru Expressway: 253 km (Tamil Nadu, Andhra Pradesh, Karnataka); Delhi Jaipur Expressway: 262 km (Delhi, Rajasthan); Kanpur Lucknow Expressway: 258 km (Uttar Pradesh); Bundelkhand Expressway: 296 km (Uttar Pradesh); Purvanchal Expressway: 340.8 km (Uttar Pradesh)
- **Proposed:** Amritsar-Kolkata Expressway: ~650 km (Punjab, Haryana, Uttar Pradesh, Bihar, Jharkhand,

West Bengal) and Chennai Surat Expressway: 1271 km (Tamil Nadu, Andhra Pradesh, Telangana, Maharashtra, Gujarat)"

International Highways

- These are the routes that connect India to its neighboring nations in order to foster a friendly connection with them. The World Bank provided funding for the construction of these roads as per an agreement with the Economic and Social Commission for Asia-Pacific (ESCAP).
- These roads link India's major highways with those of neighbouring countries such as Pakistan, Nepal, Bhutan, Bangladesh, and Myanmar.
- The India–Myanmar–Thailand Trilateral Highway, spanning 1,360 kilometers, is part of **India's Look East policy,** aiming to link **Moreh in India with Mae Sot in Thailand through Myanmar.**

India–Myanmar–Thailand Trilateral Highway

- The route, particularly the **Imphal-Mandalay-Bangkok** stretch covering 1,813 kilometers, is mostly in good condition, with a small section under upgrade to a 2-lane road by India. This enhancement is anticipated to facilitate trade within the ASEAN–India Free Trade Area and Southeast Asia.

AH1 (Asian Highway 1):

- **Route:** AH1 is a part of the Asian Highway Network, **connecting Tokyo in Japan to Istanbul in Turkey,** traversing through several countries, including India.

Fig. 10.5: India–Myanmar–Thailand Trilateral Highway

- **Indian Section:** In India, AH1 is known as **National Highway 44 (NH44),** runs from **Srinagar in Jammu and Kashmir to Kanyakumari in Tamil Nadu, covering a distance of about 3,745 km.**
- **Significance:** AH1/NH44 is a critical international trade route, linking India with neighboring countries and playing a vital role in regional economic cooperation.

AH47 (Asian Highway 47):

- **Route:** AH47 is an international highway within the Asian Highway Network, connecting the western and eastern parts of Asia. It runs from the border between Turkey and Bulgaria to the border between India and Myanmar.
- **Indian Section:** In India, AH47 is represented by **National Highway 27 (NH27),** stretching from **Porbandar in Gujarat to Silchar in Assam.**
- Significance: AH47/NH27 serves as a crucial link connecting the western and eastern regions of India, contributing to regional trade and economic integration.
- Data: NH27 has witnessed developmental projects to enhance its capacity and improve connectivity, making it an essential corridor for both domestic and international trade.
- These international highways, forming part of the Asian Highway Network, underline India's commitment to regional connectivity and integration, playing a vital role in facilitating trade and economic development across borders.

Road Network In India

- **Road transportation carries around 85% of all passengers and 70% of all goods each year.** To improve the state of India's roads after Independence, a 20-year road plan was launched in 1961.
- Over the past few decades, India has witnessed transformative strides in road infrastructure, marked by pivotal projects such as the Golden Quadrilateral, North-South and East-West Corridor, and Bharatmala Pariyojana.
- **1998:** Golden Quadrilateral (GQ) Project Launch Connects Delhi, Mumbai, Chennai, and Kolkata with four-lane highways.
- **2001:** North-South and East-West Corridor Projects Enhance connectivity between major cities.
- **2003:** Pradhan Mantri Gram Sadak Yojana (PMGSY) All-weather road connectivity in rural India.
- **2009:** Golden Quadrilateral Completion Critical milestone in inter-city travel.
- **2015:** Bharatmala Pariyojana Announcement Focus on highway development for economic corridors, border areas, and coastal regions.

Road Density in India

Road density, a critical indicator of transportation infrastructure, is measured as kilometers of road per 100 square kilometers of land. In India, various states exhibit distinct road density levels, influenced by geographical, economic, and developmental factors.

- **Highest Road Density States (km per 100 sq km):** Maharashtra (1,656) > Gujarat (1,574) > Kerala (517.77) km per 100 sq km.

- **Lowest Road Density States(km per 100 sq km):** Arunachal Pradesh (42) < Mizoram (56) < Meghalaya (64)

Challenges of Road Transport in India

1. **Traffic Congestion:** According to a 2021 report by TomTom Traffic Index, several Indian cities, including Mumbai, Delhi, and Bengaluru, rank among the most congested globally.
   - Rapid urbanization and a surge in vehicle ownership contribute to severe traffic congestion, leading to increased travel time and fuel consumption.
2. **Infrastructure Quality:** As of 2020, the World Bank reported that India's road density is about 147 kilometers per 100 square kilometers, highlighting the need for further development.
   - Inadequate road quality, potholes, and insufficient maintenance contribute to challenges in smooth transportation and increased vehicle wear and tear.
3. **Road Safety Concerns:** According to the Ministry of Road Transport and Highways (MoRTH), India reported over 1,68,491 road fatalities in 2022.
   - Inadequate enforcement of traffic rules, insufficient safety measures, and a lack of awareness contribute to a high number of road accidents and fatalities.
4. **Last-Mile Connectivity:** According to the National Institute of Urban Affairs (NIUA), achieving effective last-mile connectivity remains a challenge in urban areas.
   - Gaps in the transportation network, particularly for the final stretch of the journey, hinder seamless travel, impacting both urban and rural commuters.
5. **Environmental Impact:** The Center for Science and Environment (CSE) reported that the transport sector is a significant contributor to air pollution, with road transport being a major source.
   - Increased reliance on fossil fuels for transportation contributes to air pollution and environmental degradation, necessitating a shift towards sustainable and eco-friendly alternatives.

Way forward

Addressing the multifaceted challenges in India's road transport sector calls for strategic investments, enhanced safety measures, sustainable practices, and integrated planning.

1. **Investment in Infrastructure:** Increase budgetary allocations for road infrastructure development, focusing on the expansion and maintenance of road networks to improve connectivity and reduce congestion.
2. **Enhanced Road Safety Measures:** Strengthen enforcement of traffic rules, invest in public awareness campaigns, and implement technology-driven solutions like smart traffic management systems to reduce road accidents and fatalities.
3. **Promotion of Sustainable Transportation:** Encourage the adoption of eco-friendly modes of transport, such as electric vehicles (EVs), and invest in the development of charging infrastructure to mitigate the environmental impact of road transport.
4. **Integrated Transport Planning:** Implement integrated transport planning strategies, emphasizing last-mile connectivity through well-coordinated public transportation systems, pedestrian-friendly infrastructure, and seamless intermodal connectivity.
5. **NITI Aayog's Road Transport Strategy for New India @ 75** aims to boost economic growth by expanding the road network, **achieving Bharatmala and PMGSY targets, doubling national highway length to 2 lakh km**, minimizing single/intermediate lane NHs, and enhancing regulatory frameworks for safety and quality. **The goal includes reducing road accidents and fatalities by 50% by 2025, aligning with the Brasilia Declaration commitments.**

A comprehensive approach involving increased infrastructure investment, rigorous safety measures, sustainable transportation promotion, and integrated planning is imperative to pave the way for a resilient, efficient, and environmentally conscious road transport system in India.

IGNITE YOUR MIND

Micromobility Boom: With the rise of e-bikes, scooters, and car-sharing, how can cities balance personal mobility needs with safety, pedestrian space, and traffic management?

Recent Developments

- **Investment Plan:** National Infrastructure Pipeline (NIP) targets ₹19 lakh crore ($250 billion) for road projects (2019-20 to 2024-25) to enhance national highways, rural, and urban roads.
- **Government Allocation:** Rs 2,70,435 crore allocated to Road Transport and Highways Ministry, 25% higher than 2022-23, emphasizing infrastructure for economic recovery.
- **Specific Projects:** Bharatmala Pariyojana for 34,800 km highways at ₹5.35 lakh crore ($70 billion) and PMGSY focusing on rural road development.
- **PPP Models:** NIP emphasizes Public-Private Partnerships to accelerate project execution.
- **Economic Impact:** Investments projected to boost employment, enhance transportation efficiency, and integrate remote areas for regional development.

Roads play a pivotal role in regional development, influencing various aspects of economic, social, and cultural growth.

Case Study: The Autobahn, Germany

Background

- **Construction Initiation:** Late 1920s
- **Objective:** Development of a high-speed highway network for efficient and swift transportation.
- **Total Length:** Over 12,000 kilometers

Impacts

1. **Economic:**
   a. **Efficient Transport:** Speed up goods transport, aiding Germany's economic growth.
   b. **Industrial Corridors:** Key in forming corridors linking manufacturing hubs.
2. **Social:**
   a. **Connectivity:** Boosted urban-rural links, enhancing regional economic opportunities.
   b. **Cultural Exchange:** Made diverse regions more accessible, encouraging cultural interactions.
3. **Technological:**
   a. **Engineering Innovation:** Influenced global road engineering and technology.
   b. **Automotive Industry:** Supported the growth of Germany's high-performance vehicle industry.

The Autobahn exemplifies the significant role of road networks in economic, social, and technological development.

The road transport sector plays a pivotal role in India's economic development, connecting communities and facilitating commerce. As we move forward, sustained investment in modern infrastructure, innovative technologies, and sustainable practices is imperative for creating a resilient and efficient road network that aligns with the nation's evolving needs and aspirations.

RAIL TRANSPORT

Rail transport is a vital backbone of global connectivity, efficiently linking regions and facilitating economic growth through the movement of goods and people. **Key rail routes** like the Trans-Siberian Railway, the Eurostar, and China's high-speed networks underscore the diversity and strategic importance of railways worldwide. These networks, spanning continents and crossing diverse terrains, not only support trade but also promote cultural and regional integration.

Following are the some significance of rail transport-

1. **Global Connectivity:** Rail transport is crucial for connecting different regions, offering a reliable and efficient means of transportation for both people and goods.
2. **Economic Significance:** Railways play a vital role in global trade and economic development, facilitating the movement of large volumes of cargo over long distances.
3. **Diverse Railway Systems:** There are various types of railway systems worldwide, including high-speed trains, freight lines, and traditional passenger trains, each serving different purposes.

Important Rail Routes of the World

1. **Trans-Siberian Railway (Russia):** One of the longest in the world, it connects Moscow with the Russian Far East and the Sea of Japan.

Fig 10.6: Trans-Siberian Railway (Russia) and Trans Canadian Railway

2. **Orient Express (Europe):** A famous historical route connecting Paris to Istanbul, known for its luxury and cultural significance.
3. **Ghan Railway (Australia):** Traverses the Australian continent from north to south, linking Darwin with Adelaide.

Fig 10.7: Orient Express (Europe) and Ghan Railway (Australia)

4. **California Zephyr (USA):** A scenic route that runs from Chicago to San Francisco, crossing the Rocky Mountains and the Sierra Nevada.

Fig. 10.8: California Zephyr (USA) and Beijing-Guangzhou High-Speed Railway (China)

5. **Beijing-Guangzhou High-Speed Railway (China):** One of the world's longest high-speed rail lines, connecting two major cities in China.

RAIL TRANSPORT IN INDIA

- The first stretch of the Indian Railway, spanning 34 kilometres from **Bombay to Thane**, was built in **1853**. At the end of fiscal year 2022, the length of railway routes across India was over **68 thousand kilometres**.
- India's rail network is one of the largest in the world. It promotes economic growth by making it easier to carry both passengers and freight. In India, trains are the main means of freight and passenger transportation.
- Along with facilitating the transportation of commodities across greater distances, railways enable people to conduct a variety of activities like commerce, tourism, and religious travel.

Three types of Indian Railway on the basis of gauge width of Rails

Gauge Type	Rail Width (meters)	Percentage of Total Rail Length
Broad Gauge	1.676	74%
Metre Gauge	Variable	21%
Narrow Gauge	0.762 or 0.610	5%

ZONES OF INDIAN RAILWAYS

The largest government enterprise in the nation is Indian Railways. According to the **Railway Yearbook for March 2023**, **the Indian Railways network was 68,403 kilometres long**. Its enormous scale places a great deal of strain on a centralized railway administration system. As a result, India's railway system is split up into **19 zones**. They are Central Railway (Mumbai CSMT, CR), East Central Railway (Hajipur, ECR), East Coast Railway (Bhubaneswar, ECoR), Eastern Railway (Fairlie Place, Kolkata, ER), Konkan Railway (Navi Mumbai, KR), Metro Railway, Kolkata (Kolkata, MTP), North Central Railway (Prayagraj, NCR), North Eastern Railway (Gorakhpur, NER), North Western Railway (Jaipur, NWR), Northeast Frontier Railway (Maligaon, Guwahati, NFR), Northern Railway (Delhi, NR), South Central Railway (Secunderabad Junction, SCR), South Coast Railway (Visakhapatnam, SCoR), South East Central Railway (Bilaspur, SECR), South Eastern Railway (Garden Reach, Kolkata, SER), South Western Railway (Hubballi, SWR), Southern Railway (Chennai Central, SR), West Central Railway (Jabalpur, WCR) and Western Railway (Mumbai, Churchgate, WR).

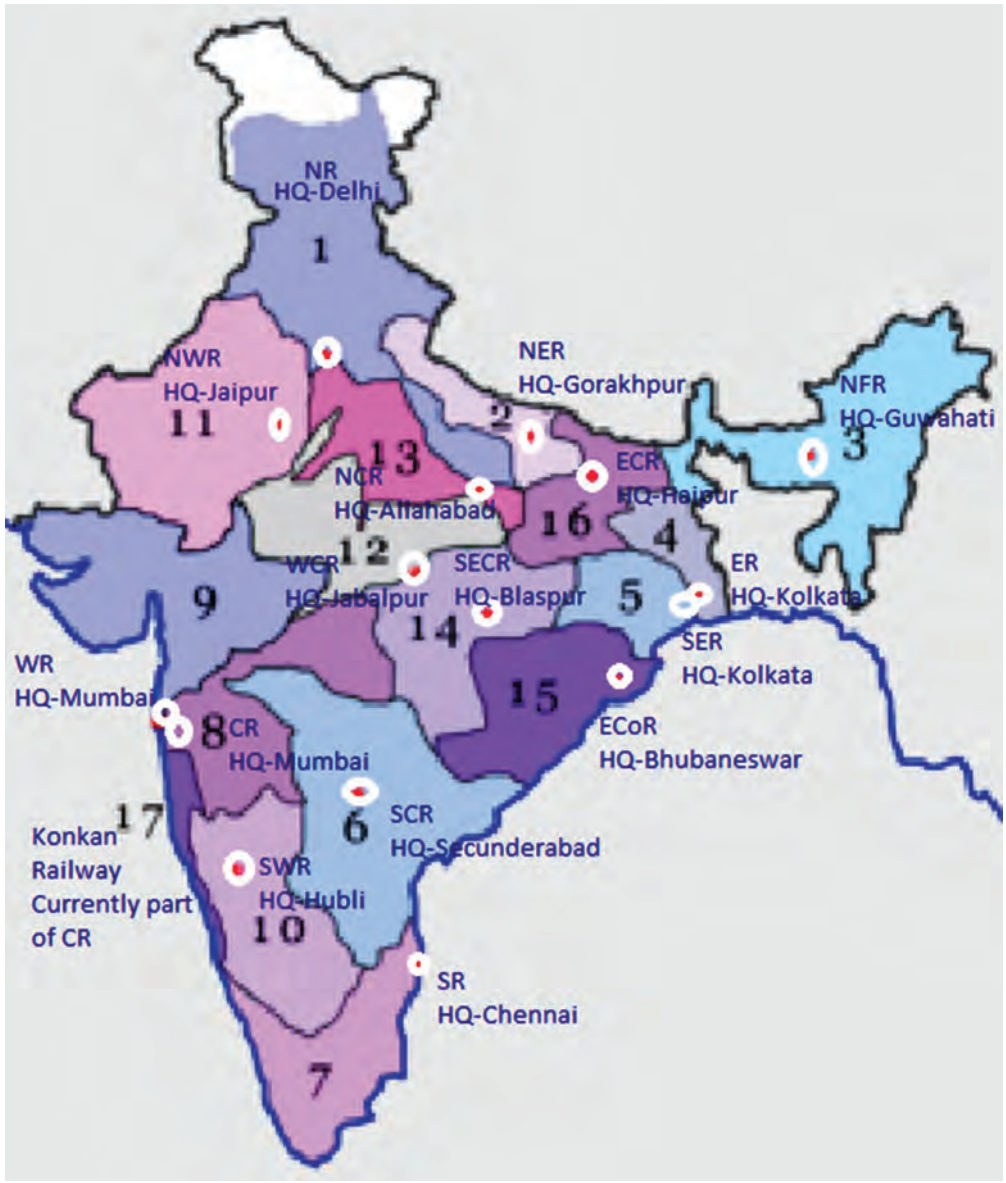


Fig. 10.9: Zones of Indian Railways

DEVELOPMENTS IN THE INDIAN RAILWAYS

Indian Railways, with a history spanning over 160 years since its inception during the British colonial era, has significantly evolved and shaped the nation. Originally built to serve colonial interests, the network's **first route extended to Kalyan in 1854** and later to Khopoli in 1856, with the **Khandala-Pune segment completing in 1858**. Indian Railways has also extensively converted meter and narrow gauges to broad gauges, replacing steam engines with diesel and electric ones, leading to increased speed and loading capacity.

Do You Know?

UNESCO has designated four Indian Railways locations as **"World Heritage Sites."** As follows:

- **Darjeeling-Himalayan Railway(1999)**
- **Nilgiri Mountain Railways (2005)**
- **Mumbai Chhatrapati Shivaji Terminus (2004)**
- **Kalka-Shimla Railways (2008)**

Key Railway Developments in India

- **1951:** Integration of Indian Railways: Unified management with the formation of Indian Railways.

- **1969 and 1988:** Rajdhani and Shatabdi Express: Introduction of high-speed trains, enhancing passenger experience.
- **1990:** Konkan Railway Corporation: Inauguration of Konkan Railway, improving west coast connectivity.
- **2014:** Mumbai-Ahmedabad High-Speed Rail Project: Collaboration with Japan, introducing bullet trains for faster travel.
- **2019:** Vande Bharat Express: Launch of India's first semi-high-speed train with indigenous technology.

These developments highlight India's continuous efforts to modernize and expand its railway network, incorporating technological advancements and improving passenger and freight services.

Metro Rail System

- Rapid transit, typically known as heavy rail or metro, is a type of high-capacity public transit that is commonly installed in metropolitan areas. A tube, tunnel, or subway is a rapid transportation system that primarily operates underground or beneath the surface. Rapid transit systems are railways, typically electric, that run on a dedicated right-of-way, inaccessible to pedestrians or other vehicles.
- On October 24, 1984, India's first metro system opened in Kolkata.
- The Urban Transport wing of the **Ministry of Housing and Urban Affairs** is the major nodal agency for coordination, assessment, and approval of Urban Transport affairs, including Metro Rail Projects. In Kolkata and Delhi, the metro has revolutionized the urban transportation infrastructure. The replacement of diesel buses with CNG-powered vehicles and the introduction of the metro are positive steps towards regulating urban air pollution.

Delhi Metro Rail System

Official Name: Delhi Mass Rapid Transit System (DMRTS)

Service Area: National Capital Region of Delhi, including Faridabad, Gurugram (Gurgaon), Noida, and Ghaziabad.

Ranking: 12th largest metro system globally.

Network Stats

Total Length: **393** kilometers.

Number of Stations: **288**.

Airport Express Line with six stations.

Metro Rail System Types in India	Description	Example
Rapid Transit	High-capacity rail system in urban areas, independent of Indian Railways, with its own right-of-way.	Delhi-Ghaziabad-Meerut RRTS Corridor
Suburban Metro Railway	Urban rail connecting suburbs to the city center, operated by Indian Railways.	Mumbai Metropolitan Railway
Rail with Medium Capacity	Higher capacity than light rail, designed for possible conversion to a normal metro.	Rapid Metro Gurgaon
Light Rail (Metro Lite)	Hybrid system between rapid transit and tram, used in cities with modest demand.	Srinagar
Metro Monorail	Single rail system for medium-capacity transportation, limited use in India.	Mumbai Monorail
Regional Transport System	Links adjacent cities or a metropolitan with smaller cities.	Delhi-Meerut RRTS
Tram	Low-capacity, slow-moving trains on city streets, one of India's oldest urban transport types.	Kolkata Tram

Role of Indian Railways

The Indian Railways, a cornerstone of India's infrastructure, transcends mere transportation. It's a vital force driving economic growth, fostering social connections, and playing a key role in tourism and regional development. Its expansive reach connects remote areas to urban centres, influencing multiple facets of India's socio-economic fabric.

- **Remote Accessibility:** Kalka-Shimla Railway connects Himalayan regions for tourism and local access.
- **Economic Catalyst:** Crucial for coal transport, sustaining industries, and meeting energy demands.
- **Social Mobility:** Facilitates rural-to-urban education, with Mumbai Local vital for daily commuters.
- **Infrastructure Development:** Mumbai-Ahmedabad route stimulates town and industry growth, spurring commercial and residential development.
- **Tourism Boost:** Heritage railways like Darjeeling Himalayan and Palace on Wheels promote tourism, preserving cultural heritage globally.

Indian Railways plays a pivotal role, fostering development in diverse sectors, from economic and social mobility to infrastructure growth and tourism promotion.

GOVERNMENT INITIATIVES TO IMPROVE THE RAILWAY SECTOR IN INDIA

National Rail Plan Vision 2030: Transforming India's Railway Network

The National Rail Plan Vision 2030 is a pioneering initiative by the Indian government to revolutionize the country's railway infrastructure.

Key Objectives

- **Network Expansion:**
  - **Freight Train Speed:** Enhance the average speed of freight trains to **50 km/h**.
  - **Passenger Train Speed:** Increase the average speed of passenger trains to **100 km/h**.
- **Electrification:**
  - **Investment:** Approximate investment of **$180 billion** over the next decade.
  - **Timeline:** Electrify the entire rail network by **2024** to significantly reduce carbon emissions.
- **High-Speed Rail Corridors:**
  - **Development:** Envision high-speed rail corridors, including the **Mumbai-Ahmedabad High-Speed Rail project**, to revolutionize intercity travel.
- **Innovation and Technology:**
  - **Emphasis:** Place importance on innovation and technology adoption to improve safety, efficiency, and passenger experience.

Government Initiatives:

- **Semi-High-Speed Rail (Pune-Nashik):**
  - **Approval:** Central Government approved a **235 km semi-high-speed rail track** between Pune and Nashik in Maharashtra in June 2021.
  - **Cost:** The project is estimated to cost **Rs. 16,039 crore**.
- **Amrit Bharat Station Scheme (2022):**
  - **Objective:** Complete redevelopment of **1309 railway stations** nationwide for an enhanced passenger experience.
  - **Focus:** Modern facilities, optimized traffic flow, connectivity, and effective passenger assistance.
- **Rail India Development Fund (RIDF) (2017):**
  - **Semi-High-Speed Rail Project:** Included in the budget for 2017-18 for **Delhi-Mumbai and Delhi-Howrah lines** with an investment of **Rs 17,000 crore**.
  - **Financing:** World Bank facilitates the fund formation with contributions from pension funds and sovereign funds.
- **Dedicated Freight Corridors (DFCs):**
  - **Objective:** Reduce freight transport costs through electrical fuel, longer trains, and double stacking of containers.

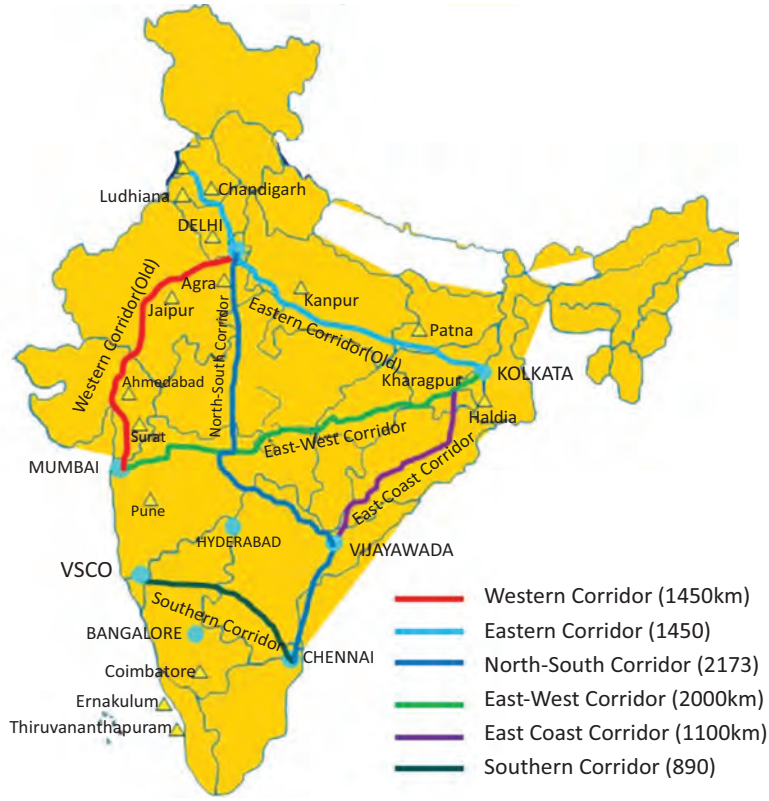


Fig .10.10: Dedicated Freight Corridors

- **Funding:** Eastern DFC (EDFC) funded by the **World Bank**, Western DFC (WDFC) funded by **Japan International Cooperation Agency (JICA)**.
- **Target:** Increase the railway's modal share from **28% to 44% by 2051**.

- **Bharat Mala Project:**
  - **Scope:** Infrastructure development initiative covering **13 states** over **5300 km**.
  - **Investment:** Ranging from **Rs 12,000 to 14,000 crores** over three years.
  - **Route:** Extends from Gujarat to Manipur and Mizoram, resembling a garland, hence titled "Bharat Mala."

New Projects in Rail Transport

1) **Regional Rapid Transit System**

The Delhi-Meerut Regional Rapid Transit System (RRTS) is a pioneering rail project designed to revolutionize connectivity and commuting efficiency between the Indian cities of Delhi and Meerut.

Implementing Authority: The National Capital Region Transport Corporation (NCRTC) – a collaborative venture involving the central government and the state governments of Delhi, Haryana, Rajasthan, and Uttar Pradesh – is responsible for executing these RRTS projects.

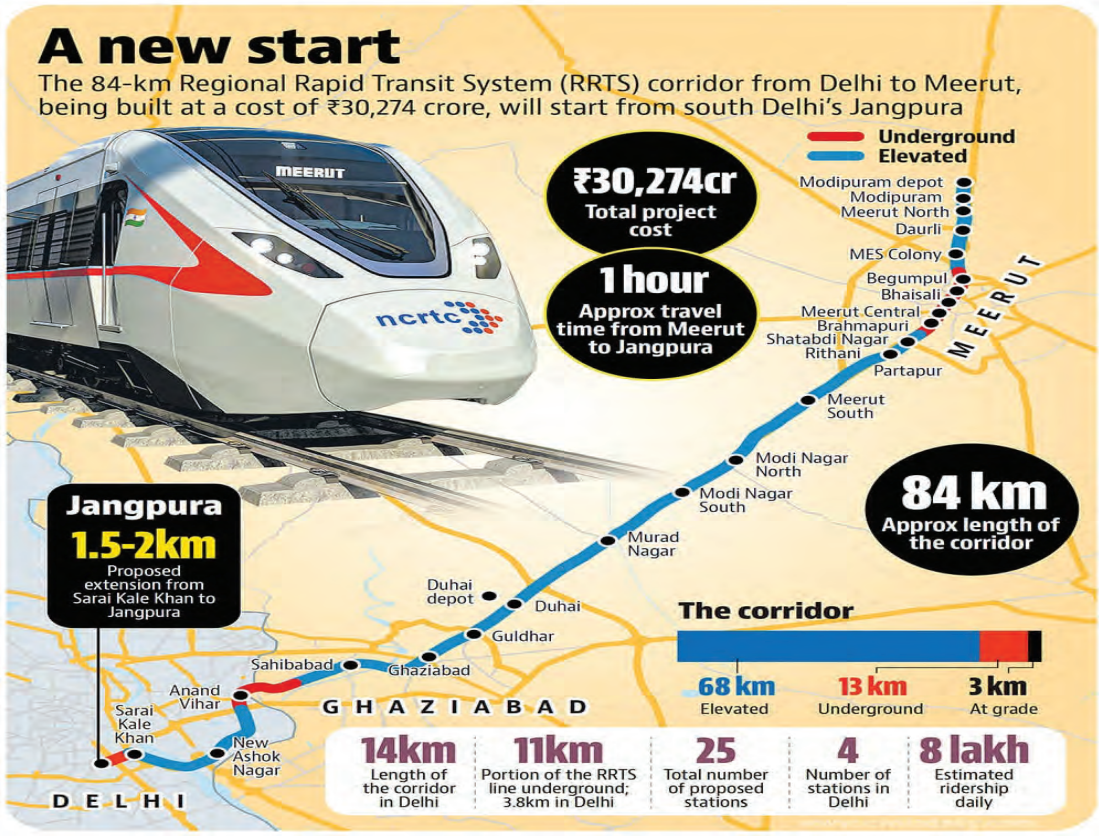


Fig. 10.11: **Regional Rapid Transit System**

2) Vande Bharat Train

India's first indigenously designed and manufactured **semi-high-speed train**, also known as **Train 18.**

TRAIN 18
India's first indigenously built engine-less train likely to begin operations from December 15
It is being regarded as a successor to the Shatabdi Express
Developed by
Integral Coach Factory, Chennai
Time taken
18 MONTHS
Estimated cost of the prototype
₹100 CR
Train 18 vs Shatabdi Express
160 KMPH
Potential speed of Train18
130 KMPH
Speed of Shatabdi Express
Source: News Reports
Features
Self-propelled train; doesn't require an engine
360 degree rotating seats
AC chair-car type coaches
Diffused lighting, automatic doors and footsteps
GPS-based Passenger Information System
CCTV cameras, Wi-Fi facility
When compared with Shatabdi
Train 18 will reduce travel time by
15%

Fig. 10.12: Vande Bharat

3) Mumbai-Ahmedabad High-Speed Rail (MAHSR)

- The Mumbai-Ahmedabad High-Speed Rail (MAHSR) project aims to connect Mumbai and Ahmedabad with a 508-kilometer high-speed rail corridor, utilizing Japanese Shinkansen technology for speeds up to 320 km/h.
- The project, a joint venture between the Indian government and JICA, seeks to significantly reduce travel time and enhance transportation efficiency between the two major cities.

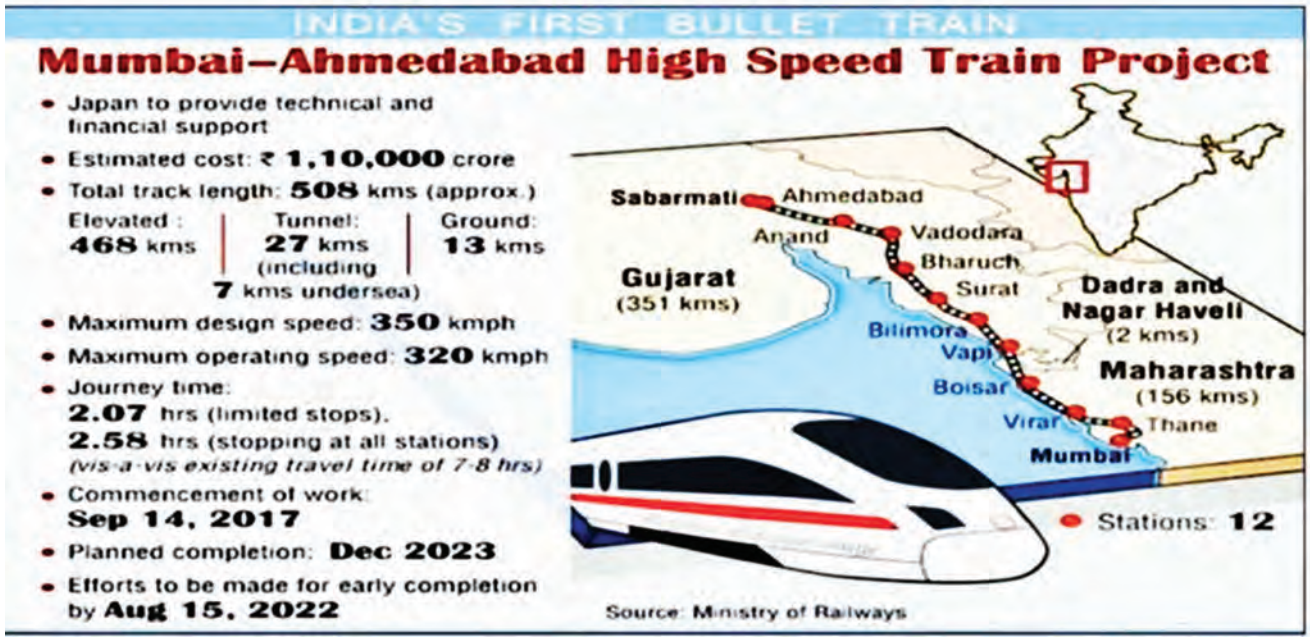


Fig. 10.13: Mumbai-Ahmedabad High-Speed Rail (MAHSR)

The above measures are some of the steps taken by the government **to modernise Indian railways and make them more competitive, efficient and customer-friendly.**

IGNITE YOUR MIND

Whispers on the Tracks: Imagine high-speed rail connecting continents, blurring cultural borders. Will seamless transport lead to homogenization or ignite a renaissance of local identities? Can law and order adapt to ensure cultural diversity thrives in this interconnected world?

Challenges in Railways Transport System in India

Indian Railways grapples with challenges like capacity constraints causing delays (59% trains), safety issues with numerous accidents, **aged infrastructure requiring Rs. 50 lakh crores ($676 billion) for a 30-year upgrade,** financial constraints relying on government funds, heightened competition, and a shortage of skilled personnel.

This overview sets the stage for a detailed exploration of these challenges in one of the world's busiest railway networks.

❑ **Capacity Constraints**:
- Over 23 million passengers and 3 million tonnes of freight moved daily.
- Limited network capacity leads to overcrowding and delays.
- The punctuality of mail and express trains has witnessed a decline, reaching 73 per cent by mid-August, 2023.

❑ **Safety Challenges:**
- High number of accidents and incidents.
- In 2022-23, 36 train accidents and 36 consequential train derailments.

❑ **Infrastructure Issues:**
- Extensive but ageing network in need of modernization.
- Insufficient infrastructure to meet growing transportation demands.
- Estimated requirement of Rs. 50 lakh crores ($676 billion) for the next 30 years.

❑ **Funding Constraints:**
- High cost of infrastructure development and modernization.
- Government provides most funding, with internal resources supporting operations.
- Total Railway Receipts during 22-23 is Rs 2,39,892 Cr, and total Railway expenditure is Rs 2,37,375 Cr.

❑ **Competition Pressure:**
- Facing competition from roadways and airways.
- Market share in freight transportation declined from 89.6% in 1950-51 to 27% in 2019-20.

- Competitive pressures necessitate service improvements.

❑ **Human Resources Shortage:**

- Shortage of skilled personnel in critical areas like safety, maintenance, and operations.
- Sanctioned strength of employees was 15.06 lakh as of March 2020, with a vacancy of 19.7%.
- Challenges in recruiting and retaining skilled workforce.

❑ **Derailment**

- The CAG's 2022 report identified major safety management deficiencies in Indian Railways.
- Derailments increased from 2018-2021 due to track defects, human errors, and rolling stock failures.
- Lack of a comprehensive derailment policy led to delays, revenue loss, and inconvenience.

Way forward

India's railway transformation focuses on high-speed rail development, public-private partnerships, digital efficiency, and sustainable practices to create a modern, efficient, and customer-centric transportation network.

Dinesh Trivedi Committee

❑ Focus on improving safety protocols and infrastructure maintenance.

❑ Encourage private investment and partnerships for the modernization of stations and infrastructure.

Bibek Debroy Committee on Indian Railways Restructuring:

❑ Recommend the restructuring of Indian Railways to enhance operational efficiency and financial sustainability.

❑ Advocate for decentralization and transparency to promote private investment and innovation.

Bibek Debroy Committee on Information and Communication Technology:

❑ Suggest the adoption of digital technologies for improved operational efficiency and customer service.

❑ Recommend upgrading IT systems for better ticketing, freight management, and real-time information sharing

Improving Railway Transport System

1. **Investment in Modern Infrastructure:** Upgrade tracks, signaling systems, and stations to improve overall efficiency and safety. Focus on adopting state-of-the-art technologies to ensure a robust and modern railway network.
2. **Customer-Centric Services:** Enhance passenger amenities, cleanliness, and digital services. Implement user-friendly technology solutions for ticketing, passenger information, and grievance redressal to improve the overall customer experience.
3. **Environmentally Sustainable Practices:** Integrate green and sustainable practices in railway operations. Invest in energy-efficient technologies, renewable energy sources, and eco-friendly infrastructure to reduce the environmental impact of railway transport.
4. **Kavach, an indigenous Automatic Train Protection (ATP) system** developed by RDSO and Indian vendors, ensures railway safety by preventing signal violations, enforcing speed restrictions, and activating automatic braking. It operates at Safety Integrity Level-4 standards and employs Traffic Collision Avoidance System (TCAS) for effective communication between station masters and loco-pilots.

Implementing these recommendations and improvements will contribute to the development of a more efficient, sustainable, and customer-friendly railway transport system in India.

To address challenges in India's railway system, a comprehensive strategy involves substantial investments in infrastructure upgrades, prioritizing safety measures, diversifying funding sources, enhancing competitiveness through innovation, and implementing targeted recruitment and training programs to alleviate the shortage of skilled personnel.

The Indian Railways' Diamond Quadrilateral project aims to build a high-speed rail network throughout India. This diamond quadrilateral will link Delhi, Mumbai, Kolkata, and Chennai, India's four major cities. There are plans to build a bullet train between Mumbai and Ahmedabad. The longest rail platform in the world, reaching 1366 metres, is at the Gorakhpur railway station.

In general, the Indian Railway Network is expanding at a stable rate. In five years, the Indian railway market will account for 10% of the global market and be the third largest network. The Indian Railways, one of the largest employers in the country, can generate one million jobs when scaled to efficient levels.

IGNITE YOUR MIND

Hyperloop's Hype: While hyperloop technology promises supersonic travel, consider its environmental impact, accessibility, and integration with existing infrastructure. Can it be a sustainable solution? Compare and contrast the feasibility, accessibility, and environmental impact of hyperloop technology with existing high-speed rail networks.

WATER TRANSPORT

The transportation of goods or people via the use of vessels navigating on the ocean or on internal water routes is called water transport. The cheapest and oldest means of conveyance is water. Except for canals, its natural

track requires little financial input in development and maintenance. The highest carrying capacity makes it ideal for long-distance heavy cargo transport. It is vital to international commerce and has brought the globe closer.

India has been a maritime nation since the beginning of time. Its sailors travelled far and wide, transporting and disseminating Indian trade and culture. 14,500 km of inland waterways are available for navigation in India. Only 5685 km of them can be navigated by mechanical vessels. The government has designated the following waterways as National Waterways.

Types of Water Transportation

In India, waterways play a significant role in both freight and passenger transportation. It is the most affordable method of transportation and works best for moving large and heavy items. It is a green and fuel-efficient means of transportation. Water transport is of two types:

1. **Inland Water Transport**
2. **Marine Water Transport**

Inland Water Transport

- Before the development of railroads, Inland waterways were the primary form of transportation. However, it had to struggle with tough competition from the railroad and roads. In addition, rivers lost much of their navigability due to the diversion of river water for cultivation.
- India has **14,500 kilometres** of large rivers, representing one percent of the country's total transportation distance. It includes rivers, canals, streams, backwaters, and so on. The major rivers are currently navigable at 5,685 km. E.g., Kolkata is an inland riverine port.
- **Inland Waterways Authority of India (IWAI)**
  - IWAI was created by the Government of India in 1986 for regulating and developing inland waterways for shipping and navigation.
  - The body chiefly undertakes development and maintenance projects of IWT infrastructure on national waterways.
  - It undertakes these projects through grants from the Shipping Ministry.
  - Its headquarters is in Noida.

Government Initiatives and Policies

The Indian government has undertaken several initiatives and implemented policies to boost the development of inland waterways:

1. **IWAI Act, 1985:** Established the Inland Waterways Authority of India as statutory body under Ministry of Ports, Shipping & Waterways (MoPS&W) to develop infrastructure on national waterways.
2. **Indian Vessels Act, 1917 (Revised in 2007):** Governs inland vessel survey, registration, and pollution control measures.
3. **Inland Water Transport Policy, 2001:** Promotes private investment in infrastructure and fleet operations, focusing on cost-effectiveness and eco-friendliness.
4. **Jal Marg Vikas Project (JMVP):** Enhances navigation on National Waterway-1 along the Ganga River, with World Bank support, targeting completion by March 2023.
5. **Project Arth Ganga:** Aims to stimulate economic growth in regions along the Ganga through the construction of small jetties.
6. **National Waterways Act, 2016:** Designates 111 water bodies as National Waterways,

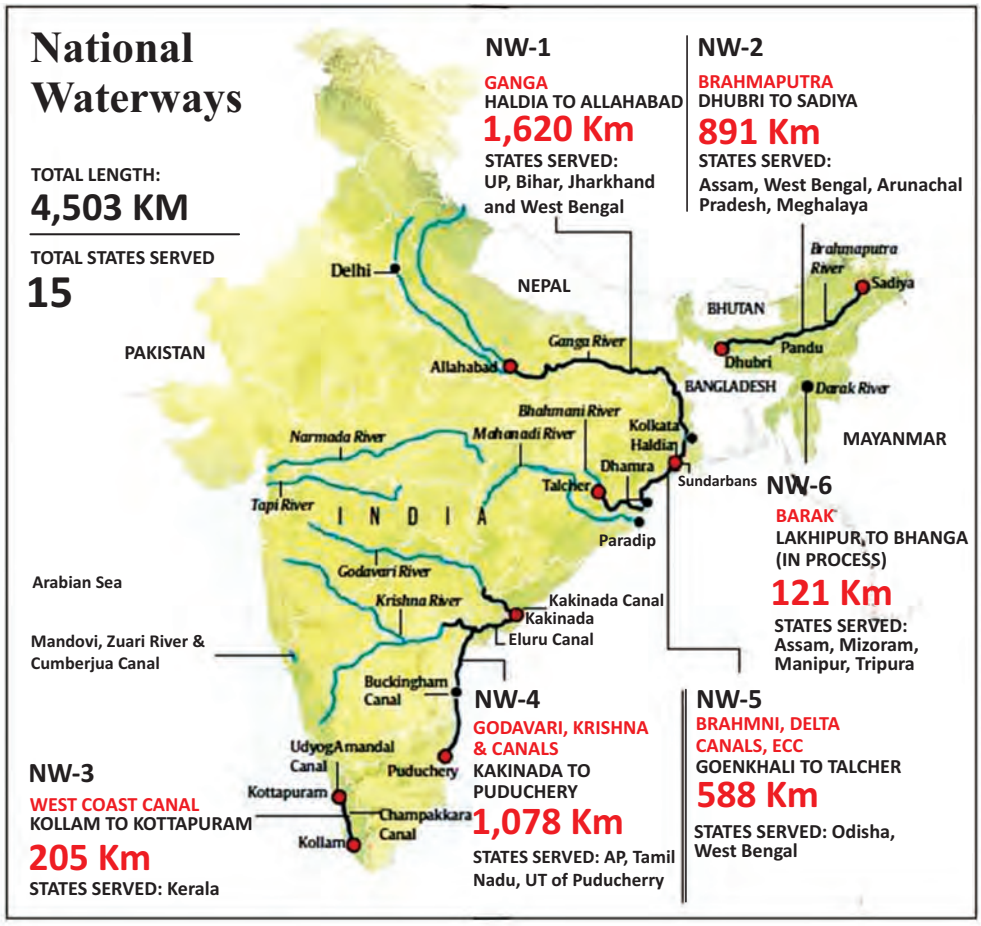


Fig. 10.14:National Waterways

enabling Central Government control over shipping and navigation.

7. **Inland Vessels Bill, 2021:** Seeks to modernize the regulatory framework for inland vessel transportation, enhancing transparency and accountability.

Challenges in Inland Water Transport (IWT)

- **Limited Navigability:** Some rivers are seasonal, impacting year-round use. About 20 of 111 national waterways deemed unviable.
- **Dredging Challenges:** Capital and maintenance dredging required for all waterways. Local resistance due to environmental concerns hampers implementation.
- **Competing Water Uses:** Water resources essential for living, irrigation, and power. Balancing diverse needs poses significant challenges.
- **Exclusive Central Government Jurisdiction:** Central government has exclusive jurisdiction over 'national' waterways. Other waterways fall under concurrent list or state government jurisdiction.

Way Forward for IWT

- **Multi-Seasonal Navigability Solutions:** Invest in technologies for year-round river navigability.
- **Sustainable Dredging Practices:** Implement eco-friendly dredging techniques, engage with local communities.
- **Integrated Water Resource Management (IWRM):** Adopt IWRM for equitable water use, ensuring IWT complements other needs.
- **Cooperative Federalism Approach:** Encourage collaboration for efficient management of non-national waterways.

Adopting these measures can overcome challenges, paving the way for an integrated, sustainable, and efficient Inland Water Transport system in India.

Do You Know?

There are additional inland waterways that play a significant role in transportation. This includes the Sunderbans, Barak, Mandavi, Zuari, and Cumberjua, along with the backwaters of Kerala.

RoRo Service in India

- Roll-on/Roll-off (RoRo) service in India refers to a mode of maritime transport where wheeled cargo, such as cars, trucks, and trailers, can be driven onto and off a vessel. The RoRo service simplifies the loading and unloading process, making it more efficient and cost-effective.
- Mode of maritime transport for wheeled cargo, enhancing efficiency.
- Particularly useful for coastal routes, reducing road congestion.
- **Examples:**
  - **Mumbai-Goa RoRo Ferry:** Connects Mumbai and Goa, offering convenient vehicle transportation.
  - **Cochin International Container Terminal (CICT):** Implements RoRo facilities in Kochi, promoting efficient cargo handling and maritime connectivity.

Marine Water Transport:

India has 13 major ports and about 200 non-major ports along a 7,517 km coastline.

- **Major Ports:**
  - **East coast:** Kolkata, Paradip, Visakhapatnam, Kamarajar, Chennai, V.O. Chidambaranar.
  - **West coast:** Cochin, New Mangalore, Mormugao, Mumbai, Jawaharlal Nehru Port, Deendayal.

  Major ports handle 57% of total traffic in India's ports, while non-major ports handle 43%.
- **Major Seaports:**
  - 205 recognized non-major ports, with 95% of India's international trade handled by major ports.
  - Major ports regulated by Indian Ports Act of 1908 and Major Port Trust Act of 1963.

Major Ports in India:

- **Kolkata Port:**
  - Only significant riverine port on the Hooghly River.
  - Twin dock systems at Haldia Dock Complex and Kolkata Dock System (KDS).
  - India's oldest active port.

Fig. 10.15: Major Ports of India

- **Paradip Port:**
  - Located in Odisha at Mahanadi River's confluence with the Bay of Bengal.
  - Handles iron, aluminum exports, and supplies iron ore to Japan.
  - First important port created after independence.
- **New Mangalore Port:**
  - Situated in Karnataka at Gurupura River's junction with the Arabian Sea.
  - Deals with iron ore, molasses, coffee, tea, wood pulp, and more.
  - All-season, deepwater port.
- **Cochin (Kochi) Port:**
  - Natural harbor in Kerala, known as the Queen of the Arabian Sea.
  - Serves Kerala, southern Karnataka, and southwestern Tamil Nadu.
  - India's first transshipment facility.
- **Jawaharlal Nehru Port:**
  - India's greatest container terminal, also known as Nhava Sheva Port.
  - Handles a significant portion of container traffic.
  - India's biggest man-made port.
- **Mumbai Port:**
  - India's largest natural harbor and port.
  - Specializes in mineral oil, liquid chemicals, and petroleum products.
  - Main routes from the Middle Eastern, Mediterranean, North African, North American, and European countries.
- **Kandla Port:**
  - Tidal port in Kuchchh, designated as Deendayal Port.
  - Largest port by goods handled, designated as a Free Trade Zone.
  - Constructed soon after Independence to lessen traffic on the Mumbai port.
- **Vishakhapatnam Port:**
  - Located in Andhra Pradesh, handles most freight along the East Coast.
  - Deepest port in India, trades coal, alumina, iron ore, and oil.
  - Three primary harbors: fishing, inner, and outer.
- **Chennai Port:**
  - Second-largest port in India, located in Tamil Nadu.
  - Manmade harbor, ideal for smaller ships.
- **Tuticorin Port:**
  - Known as V.O. Chidambaranar Port, a man-made harbor in the Gulf of Mannar.
  - Renowned for pearl fishing, trades in coal, salt, petroleum products, and fertilizers.
- **Mormugao Port:**
  - Located on the Juari River's estuary, serves as a natural harbor.
  - India's most important iron ore exporting port.
- **Ennore Port:**
  - India's 12th major port, the country's first publicly traded port.
  - Trades in iron ore, coal, petroleum products, and chemicals.
- **Vadhavan Port:**
  - India's 13th major port, aiming to be a top-ten container port globally.
  - Planned as an 'All Weather, All Cargo' satellite port by JNPT.
- **Port Blair Port:**
  - Newest significant seaport in the Andaman and Nicobar Islands.
  - Strategically significant, closer to major shipping linesSaudi Arabia-Singapore and US-Singapore.

The development and efficiency of ports play a pivotal role in a nation's economic growth. In the Indian context, however, several challenges impede the optimal functioning of ports, hindering their ability to contribute effectively to trade and commerce. These **challenges** include:

- **High Turnaround Times:** Indian ports face extended ship turnaround times, exceeding two days compared to Singapore's under a day.
- **Port Congestion:** Major concern due to container volume, lack of handling equipment, and ineffective operations.
- **Sub-optimal Transport Modal Mix:** Inadequate infrastructure for evacuation from major and minor ports results in a poor modal mix of transportation.
- **Limited Hinterland Linkages:** Poor hinterland connectivity via rail, road, highways, coastal shipping, and inland waterways leads to inefficiency and increased transportation costs.
- **Lengthy Inspection and Scrutiny:** Despite digitization of customs operations, cargo inspections and scrutiny processes remain prolonged.
- **Inadequate Infrastructure and Technology:**Lack of berthing facilities, berth numbers, and material handling tools for quick turnaround at non-major ports and their insufficient capacity to handle larger vessels impacts international trade.
- **Issues with Regulations:** Varied jurisdictions for major and non-major ports, stringent laws against piracy and restrictions on foreign-flagged ships transporting cargo between Indian ports creates regulatory complexities.
- **Problems with the PPP Model:** Severe restrictions on private operators (limitations on the types of cargo they can handle), historical issues with tariff regulation and dispute resolution mechanisms.

- **Discriminatory Provisions for Indian Vessels:** Indian vessels are subject to bunker fuel duty, while foreign vessels are exempt.
- **Environmental Impact:**
  - Environmental impact due to lax enforcement of laws during port operations.
  - Spills, leaks, and oil pollution during cargo operations.
  - Risk to marine ecosystems from ballast water discharge and ship cleaning water.
  - Adverse effects on water productivity and fisheries from increased sedimentation due to dredging.

Models of Port Development

- **Service Port Model:** In this model, the port authority assumes ownership of all land and assets, including fixed and mobile infrastructure. Additionally, the port authority manages all port operations and regulatory duties.
- **Port Landlord Model:** Under this model, private businesses take charge of port operations, particularly cargo handling. Meanwhile, the publicly governed port authority functions as a landlord and regulator. The infrastructure is leased to private businesses, who are responsible for providing and maintaining their own facilities and equipment for cargo handling. Ownership of the port remains with the port authority.

Government Initiatives

- **Sagarmala Program, 2015:** Focuses on modernizing and developing ports, Enhances port connectivity and supports coastal communities, Aims to stimulate port-linked industrialization, Targets reduction of logistics costs for foreign and domestic trade, Aims to double the share of water transportation in the modal mix.
- **Central Road and Infrastructure Fund:** Create under Central Road Fund Act, 2000, Inclusion of projects and infrastructure sub-sectors, including inland waterways, Renamed as the Central Road and Infrastructure Fund.
- **Draft Indian Ports Bill 2021:** Aims to centralize the administration of minor ports, Currently managed by state governments.

Way Forward

- **Standardization for Foreign Investment:** Implement standardized processes for environmental clearances, tariff rules, and land acquisition to attract foreign investment.
- **Enhanced Multimodal Connectivity:** Provide robust rail and road connectivity to major and minor ports to ensure seamless multimodal transportation, fostering overall efficiency.
- **Capacity Expansion and Operational Efficiency:** Prioritize expanding capacity and enhancing operational effectiveness in ports, Install advanced cargo handling procedures, scalable operations, and mechanization for improved efficiency.
- **Utilization of Technology:** Leverage big data and cutting-edge GPS navigation systems to their full potential for enhanced port functionality.
- **Simplified Regulatory Regime:** Advocate for a less rigid and complex regulatory regime to streamline processes and encourage comprehensive port development.
- **Vertical Integration of Stakeholders:** Promote vertical integration among all stakeholders for the holistic development of India's ports.
- **Sagarmala Project Implementation:** Execute the Sagarmala project for port modernization, new port development, improved port connectivity, industrialization linked to ports, and development of coastal communities, Capitalize on the project's potential to reduce transportation and logistics costs, enhancing export competitiveness.
- **Dredging Market Opening:** Open up the dredging market, particularly to international players, to increase and maintain draught depth at ports, Attracting more players in dredging is essential to accommodate large vessels and establish hub ports.

Maritime India Vision 2030

- It is a **ten-year blueprint** for the maritime sector which was released by the Prime Minister at the Maritime India Summit in November 2020.
- It will supersede **the Sagarmala initiative** and aims to boost waterways, give a fillip to the shipbuilding industry and encourage cruise tourism in India.

Policy Initiatives and Development Projects

- **Maritime Development Fund:** A Rs. 25,000-crore fund, which will provide low cost, long-tenure financing to the sector with the Centre contributing Rs. 2,500 crores over seven years.
- **Port Regulatory Authority:** A pan-India port authority will be set up under the new Indian Ports Act Bill, 2023 (to replace the old Indian Ports Act, 1908) for enabling oversight across major and non-major ports, enhance institutional coverage for ports and provide for structured growth of the ports sector to boost investor confidence.
- **Eastern Waterways Connectivity Transport Grid project:** It will aim to develop regional connectivity with Bangladesh, Nepal, Bhutan and Myanmar.
- **Riverine Development Fund:** Calls for extending low cost, long-term financing for inland vessels with the support of a Riverine Development Fund (RDF) and for extending the coverage of the tonnage tax scheme (applicable to ocean-going ships and dredgers) to inland vessels also to enhance the availability of such vessels.

- **Rationalisation of Port Charges:** It will make them more competitive, besides doing away with all hidden charges levied by ship liners to bring in more transparency.
- **Promotion of Water Transport:** For decongestion of urban areas, and developing waterways as an alternative means of urban transport.

A port, located along a coast, is a key hub for ships and cargo transportation. To enhance Indian ports, focus on improving service quality and optimizing intermodal infrastructure for efficient door-to-door containerized foreign trade.

AIR TRANSPORTATION

- Air travel is the quickest, most expensive, most sophisticated, and most pleasant method of transportation. Air travel promotes connectivity on a national, regional, and worldwide scale. It has facilitated access by linking tough terrains such as steep mountains and sandy deserts. It transports passengers, freight, and mail. Air transport is critical in times of emergency and in the aftermath of natural and man-made disasters such as floods, epidemics, and conflicts.
- The **Airports Authority of India (AAI)** was established in 1995. It ensures airport security in India. The AAI, which is part of the Ministry of Civil Aviation, is in charge of developing, upgrading, maintaining, and administering civil aviation infrastructure in India.
- India's domestic aviation sector, initially handling a few million passengers annually in the early 1990s, experienced significant growth following the liberalization policies of the late 1990s. By the mid-2000s, passenger numbers had increased to 30-40 million, thanks to economic expansion and the entry of low-cost carriers.
- The 2010s saw a further boom, with passenger counts exceeding 100 million by the decade's end, establishing India as one of the fastest-growing aviation markets globally.
- In March 2023, the total number of passengers transported by domestic carriers in India reached 13 million.
- According to the **Civil Aviation Ministry,** the projection for the fiscal year 2024 alone anticipates a substantial increase, with more than 140 million passengers expected to be served.

Fig. 10.16: **Airports In India**

- Looking ahead, India is poised to handle over 1.3 billion passengers annually over the next two decades.
- The country currently boasts 148 airports, solidifying its position as the **third-largest domestic market** globally in terms of seat capacity. Notably, the domestic aviation landscape is marked by dynamic market leaders.
- As of March 2023, IndiGo leads the pack with an impressive 56.8% market share, followed by Vistara at 8.9% and Air India at 8.8%.
- This data underscores the robust growth and significance of the aviation sector in India, highlighting its potential to become a key player in the global aviation industry.

Intercontinental Air Routes

- In the Northern Hemisphere, there is a clear east-west belt of transcontinental aviation routes. Eastern and Western Europe, as well as Southeast Asia, all have extensive networks.
- The **United States alone has 60% of the world's airways.** London, New York, Paris, Amsterdam, and Frankfurt are among the cities represented.
- At Rome, Moscow, Karachi, New Delhi, Mumbai, Bangkok, Singapore, Tokyo, San Francisco, Los Angeles, and Chicago, air routes converge or radiate to all continents. There are no air services in Africa, South America, or the Asian region of Russia.
- Due to reduced population density, less landmass, and weaker economic growth in the Southern Hemisphere, there are fewer aviation services between 10 and 35 degrees latitude.

Role of Aviation Sector in Regional Development:

- **Economic Returns:** The expansion of airports in cities like **Bengaluru and Hyderabad** has not only boosted air travel but also spurred economic growth in the surrounding regions, attracting investments and creating job opportunities.
- **Growth Pole Functionality: The Kempegowda International Airport in Bengaluru acts as a growth pole,** driving economic activities in Devanahalli and surrounding areas. The airport's presence has led to the development of hotels, restaurants, and other services, contributing to the region's growth.
- **Tourism Promotion:** The growth of domestic air travel has significantly contributed to the tourism industry in Goa. **The Dabolim Airport** has played a vital role in promoting tourism, leading to the development of infrastructure to accommodate the increasing number of visitors.
- **Infrastructure Development:** The expansion of the **Cochin International Airport in Kerala** has catalyzed the development of infrastructure in the nearby areas, including improved road networks and transportation facilities.
- **Skill Enhancement:** The growth of the aviation sector in Hyderabad has led to increased demand for skilled professionals. This has resulted in the establishment of aviation training institutes, enhancing the skills of the local workforce.
- **Cultural Preservation:** Tourism around the **Taj Mahal in Agra,** facilitated by air travel, has not only contributed to the economic well-being of the region but also promoted local crafts and traditions, preserving cultural heritage.
- **Exchange of Ideas and Innovation:** The aviation boom in cities like Pune has facilitated the exchange of ideas and innovations, with the city becoming a hub for technology and education, attracting professionals and students from across the country.
- **Preventing Extreme Regionalism:** In the **northeastern state of Sikkim, the Pakyong Airport** has increased accessibility, reducing isolation and allowing for a more significant focus on addressing local issues, fostering connectivity with the rest of India.

These examples underscore how the aviation sector in India has played a pivotal role in the holistic development of regions, contributing to economic prosperity, cultural preservation, and social connectivity.

Challenges in Indian Aviation Sector

The Indian aviation industry, while experiencing significant growth, grapples with various challenges that impact its operational efficiency and economic viability.

- **Aviation Turbine Fuel (ATF) Cost:** Airfares in India remain 15% below the break-even point, with ATF costs constituting a substantial portion (40-50%) of carriers' operational expenses.
- **Tax on ATF:**
  - Some Indian states impose high taxes, up to 30%, on jet fuel, particularly affecting the profitability of shorter flight routes for smaller airlines.
  - Larger carriers like IndiGo leverage their size to offer lower fares on these routes, offsetting costs.
  - Issues in National Civil Aviation Policy:
    - Historically, the National Civil Aviation Policy has favored established players. Prior to 2016, new airlines faced stringent criteria, such as a five-year operational requirement and a fleet of 20 aircraft for international operations.
    - Although the policy was revised in 2016, it still mandates domestic airlines to possess a minimum of 20 aircraft for domestic operations.
- **High Lease Costs:** Approximately 80% of India's commercial fleet operates under lease agreements, with annual lease rents amounting to around ₹10,000 crore, representing nearly 15% of airlines' revenues.
- **Dollar-Rupee Volatility:** The volatility in the exchange rate between the US dollar and the Indian rupee poses a significant challenge. Leases being denominated in US dollars lead to increased operational costs when the rupee depreciates. Government initiatives to establish leasing companies in India aim to mitigate this challenge.
- **High Service Charges and Low Ticket Prices:** Airlines face the dual challenge of paying high service charges for airport facilities while striving to maintain competitive edge through low ticket prices.Privatization of airports raises concerns about potential fee increases, impacting the cost dynamics for airlines.
- **High Training Costs of Crew:** Training airline crew is a costly affair, and a shortage of pilots persists due to a lack of Flight Training Organizations.Government efforts to address this issue are crucial for sustaining the industry's growth.

- In conclusion, addressing these challenges is imperative for the Indian aviation sector to continue its upward trajectory, ensuring sustainable and profitable operations for all players.

Recognizing the pivotal role of the aviation sector in economic development, the Indian government has implemented several strategic measures to foster growth and sustainability in the industry.

- **GST Rate Reduction for MRO Services:**
  - The government has taken a proactive step by reducing the Goods and Services Tax (GST) rate from 18% to 5% for domestic Maintenance, Repair, and Overhaul (MRO) services. This move aims to make MRO services more cost-effective for domestic carriers.
- **Extension of ECLGS 3.0 Benefits:**
  - The civil aviation sector has been included in the Emergency Credit Line Guarantee Scheme (ECLGS) 3.0, providing financial support and extending credit facilities to ensure the sector's liquidity and operational continuity.
- **Promotion of Private Investments in Airports:**
  - The government has encouraged private investments in both existing and new airports through the Public-Private Partnership (PPP) route. This initiative aims to enhance infrastructure, improve services, and attract investments for the development of the aviation sector.
- **Regional Connectivity Scheme (RCS) - UDAN**
  - **Objective:** Enhance affordable air travel and regional connectivity.
  - **Key Features:** Caps airfares, provides financial incentives to airlines, and aims to operationalize 100 under-utilized airports by 2024.
    - The Regional Connectivity Scheme (RCS), known as UDAN (Ude Desh ka Aam Naagrik), launched in 2016 by India's Ministry of Civil Aviation, aims to make air travel affordable and improve connectivity to underserved and unserved regions.
  - **Impact:** Has connected numerous new routes and revived several airports, significantly improving regional connectivity.
    - The operation of the Regional Connectivity Scheme (RCS) - Ude Desh Ka Aam Nagrik (UDAN) has been instrumental in promoting air connectivity to unserved and underserved airports, particularly in Tier-II and Tier-III cities. This initiative stimulates regional growth and facilitates affordable air travel for citizens.
  - **Budget:** Part of the Ministry of Civil Aviation's budget, with specific allocations for **Viability Gap Funding (VGF)** varying annually based on operational needs.

UDAN focuses on making air travel accessible to a wider population, thereby fostering economic growth and tourism across India.

- **Efficient Airspace Management and Route Rationalization:**
  - Collaborating with the Indian Air Force, the government has undertaken route rationalization in the Indian airspace. This strategic move aims to enhance airspace management, establish more efficient routes, and reduce fuel consumption, contributing to environmental sustainability.

These comprehensive measures underscore the government's commitment to fostering a conducive environment for the growth of the aviation sector. By addressing taxation concerns, providing financial support, promoting regional connectivity, and enhancing operational efficiency, the government aims to position the Indian aviation industry for sustained success and global competitiveness.

The Indian aviation sector is on the brink of transformative opportunities, driven by strategic initiatives and visionary planning. From fleet expansion and growing demand for **Maintenance, Repair, and Overhaul (MRO)** services to the development of inter-regional hubs and innovative economic models, the industry is set for remarkable growth. This overview encapsulates the dynamic opportunities that define the current and future trajectory of the Indian aviation landscape.

Opportunities in the Indian Aviation Sector

- **Fleet Expansion:**
  - Indian carriers are poised to substantially increase their fleet size to 1,100 aircraft by 2027, presenting a significant opportunity for growth and market penetration.
- **MRO Services Demand:**
  - The consistent double-digit growth in the aviation sector has led to an increasing demand for Maintenance, Repair, and Overhaul (MRO) services in India. This presents a lucrative opportunity for companies operating in this segment.
- **Development in North-East States:**
  - The Airports Authority of India (AAI) is strategically planning to develop Guwahati as an inter-regional hub to boost the aviation industry's development in the North-Eastern states, unlocking new avenues for regional connectivity and economic growth.
- **Aerotropolis Model Adoption:**
  - Indian airports are adopting the Special Economic Zone (SEZ) Aerotropolis model to diversify revenue streams. This model focuses on generating income from retail, advertising, vehicle parking, security services, and equipment, contributing to enhanced financial sustainability.

❑ **PPP Airport Development Projects:**

- Three major airports under Public-Private Partnership (PPP) – Delhi, Hyderabad, and Bengaluru – are undertaking developmental projects with a cumulative investment of INR 30,000 Crores by 2025. This creates opportunities for infrastructure development and economic growth.

❑ **Promotion of Air Sports:**

- The Government of India envisions making the country one of the top air sports nations by 2030. This mission aims to establish a safe, affordable, accessible, enjoyable, and sustainable air sports ecosystem in India, presenting opportunities for various stakeholders.

Way Forward for Indian Aviation Sector

❑ **Enhance Aviation Infrastructure:**

Complete ongoing projects swiftly under the UDAN initiative, and expand the capacity of international airports through the International UDAN initiative.

- Government's focus on making India a global hub for Aircraft Maintenance, Repair, and Overhaul (MRO) services will lead to cost savings and liquidity creation for airline companies.
- Foster convergence between civil MROs and the defense sector to achieve economies of scale and long-term benefits.
- Develop long-term plans for advanced research in aviation technologies to establish a robust manufacturing ecosystem in the country.

❑ **Address Shortage of Skilled Manpower:**

- Promote collaboration between original equipment manufacturers (OEMs), industry, and educational institutes to assimilate the latest technology and management practices in the aviation sector.

❑ **Augment Finances:**

- Align taxation and pricing structure of aviation turbine fuel (ATF) with global benchmarks, possibly by considering its inclusion under the Goods and Services Tax (GST).
- Monetize vacant real estate near Airports Authority of India (AAI) airports in major centers to boost non-aeronautical revenues.

❑ **Make India a Transshipment Hub:**

- Position India as a transshipment hub in the region to enhance its trading capacity, becoming a foreign exchange earner and promoting better connectivity in the region.

These strategic steps can propel the Indian aviation sector towards sustained growth, increased efficiency, and global prominence.

Air transport stands as a pivotal force in global connectivity, fostering rapid travel, efficient cargo transportation, and economic growth. With its unparalleled speed and accessibility, the aviation industry continues to play a vital role in shaping the modern world, breaking barriers and facilitating international trade and tourism.

Do You Know?
Henry Piquet launched air transport in India on February 18, 1911, when he conducted a courier mission from Allahabad to Naini. In 1953, eight distinct airlines operating in the country were nationalized.

Pipeline Transport Worldwide

Pipeline transport is a crucial mode of transportation globally, particularly for the efficient and reliable movement of liquids and gases. Major pipelines connect key regions, facilitating the transfer of energy resources and other commodities.

Pipeline Type	Pipeline Name and Location	Description
Energy Pipelines	Trans-Siberian Pipeline, operated by Transneft, Russia	Spans thousands of kilometers, transporting oil from Siberia to Russia's western ports, playing a pivotal role in global energy markets.
Natural Gas Pipelines	Nord Stream, Europe	Connects Russia to Germany through the Baltic Sea, ensuring a stable supply of natural gas to European nations.
Water Pipelines	California Aqueduct, USA	A vast network supplying water to agricultural and urban areas in California, addressing the region's water needs amidst frequent droughts.
Petrochemical Pipelines	Keystone Pipeline, USA and Canada	Facilitates the transportation of crude oil from Canada to refineries in the United States, enhancing North American energy infrastructure.
Slurry Pipelines	Iron Ore Pipeline, Brazil	Extensive pipelines transport iron ore from mines to coastal ports for export, crucial for Brazil's mining industry.
Industrial Pipelines	West-East Gas Pipeline, China	Spans thousands of kilometers, delivering natural gas from Xinjiang to Shanghai, supporting China's industrial growth and energy demands.

Pipelines play a pivotal role in global transport, ensuring the efficient movement of energy resources, water, and industrial materials. These essential networks contribute significantly to economic development and resource distribution on a worldwide scale.

Pipeline Transport in India

Fig. 10.17: **Pipelines in India**

- The pipeline transportation network is a recent addition to India's transportation. They were once utilised to transport water to cities and industries. Transporting crude oil, petroleum products and natural gas from oil and gas fields to refineries, fertiliser factories and large thermal power plants is one of the current applications of the pipelines.
- When solids are turned into slurry, they can also be conveyed through a pipeline. Pipelines connect oil fields to refineries, ports, and local markets throughout Europe, Russia, West Asia, and India. **Oil India Ltd. constructed Asia's first cross-country pipeline**, running 1,157 km from Assam's Naharkatiya oil field to Bihar's Barauni refinery. It was extended to Kanpur in 1966.

A vast network of pipes has been constructed in western India, the most notable of which are:

- **Ankleshwar-Koyali Pipeline:** In 1965, the Ankleshwar-Koyali pipeline was constructed. This pipeline conveys petroleum oil from Ankleshwar oilfield to Koyali refinery.
- **Mumbai High Pipeline:** This is a 210-kilometer-long double-pipeline joining Mumbai to Mumbai High. It provides transportation for crude oil and natural gas.
- **Ankleshwar- Kayoli:** The Ankleshwar-Koyali pipeline was finished in 1965. It transports crude oil from the Ankleshwar oilfield to the Koyali refinery.
- **Hazira-Vijaipur-Jagdishpur (HVJ):** The development of this pipeline has been undertaken by the Gas Authority of India Limited (GAIL) for the purpose of gas transportation.
  - The length of the mentioned infrastructure spans around 1,750 km, linking Hazira in Maharashtra to Bijapur in Madhya Pradesh, as well as Jagdishpur in Uttar Pradesh.
  - The pipeline transports a daily volume of 18 million cubic meters of gas to **three power stations** located in Kawas (Gujarat), Anta (Rajasthan), and Auraiya (Uttar Pradesh), as well as to **six fertilizer plants** situated in Bijapur, Sawai Madhopur, Jagdishpur, Shahjahanpur, Aonla, and Babrala.
- **Naharkatia-Nunmati-Barauni Pipeline:** This was **India's first pipeline**, built to transport crude oil from the Naharkatia oilfield to Nunmati. Oil India Limited constructed it to carry crude oil from the Naharkatia oil field in Assam to the Barauni refinery via the Noonmati oil refinery.
- **Salaya-Koyali-Mathura Pipeline:** A 1256-kilometer pipeline between Salaya, Gujarat, and Mathura, Uttar Pradesh, was recently constructed. It carries crude oil from Gujarat to Punjab (Jalandhar) through Mathura. OIL is constructing a 660-kilometre pipeline linking Numaligarh and Siliguri.

Do You Know?

Oil India Limited (OIL), a subsidiary of the Ministry of Petroleum and Natural Gas, conducts exploration, production, and transportation of petroleum oil and natural gas. In 1959, the business was incorporated from the Naharkatiya oilfield in Assam to the Barauni refinery in Bihar. This was Asia's first cross-country pipeline constructed by Oil India Limited, spanning 1,157 kilometres. The line was extended to Kanpur in 1966.

Importance of Pipeline Network in India:

- **Safe & Reliable Transport:** Pipelines ensure safer, reliable, and continuous transport of oil, gas, and water with minimal accidents and leakages.
- **Cost-Effectiveness:** Cost-efficient due to no driver/operator costs, lower maintenance, and reduced energy consumption, facilitated by pumps.
- **Environmental Friendliness:** Minimizes pollution, produces no emissions, experiences fewer leakages, and requires less land, promoting sustainability.
- **Bulk Transport Capacity:** Handles large volumes continuously, meeting diverse sector demands and facilitating bulk supply of petroleum products.
- **Resource Conservation:** Minimizes wastage, ensures timely delivery, and promotes efficient resource use, contributing to sustainability.
- **Sustainable Development:** Crucial for achieving environmental goals and ensuring sustainable resource usage.

Challenges in Pipeline Transportation

- **Frequent Leakages:** Old pipelines prone to corrosion, leading to cracks, holes, and leakage issues.
- **Project Implementation Delays:** Challenges in land acquisition, clearance, and permission lead to common delays and cost overruns.
- **Under-utilization & Investment Hold-ups:** Delays result in under-utilization, affecting timely infrastructure development and causing investment hold-ups.
- **Security Threats & Sabotage:** Susceptible to theft, attacks, and sabotage by criminal gangs, militants, and Naxal groups.
- **Operational Challenges & Security Costs:** Security threats disrupt operations, increasing security costs for counteracting sabotage.

Way forward

Pipeline transportation, a vital component of global infrastructure, faces multifaceted challenges ranging from structural issues to security threats. Addressing these challenges is crucial for sustaining the reliability and effectiveness of pipeline networks worldwide.

- **Investment in Modernization**: Prioritize upgrading aging pipelines with high-grade steel, advanced anti-corrosion measures, and regular maintenance to mitigate leakages, enhancing the reliability and safety of the network.
- **Streamlined Regulatory Processes:** Implement streamlined regulatory frameworks to expedite project approvals, land acquisition, and clearances, reducing implementation delays and minimizing cost overruns for pipeline expansion projects.
- **Integrated Security Measures:** Develop comprehensive security protocols, including advanced surveillance technologies and collaboration with law enforcement, to deter and counteract security threats, ensuring the uninterrupted operation of pipelines and safeguarding critical infrastructure.

Embracing modernization, streamlining regulatory processes, and implementing robust security measures are imperative for overcoming challenges in pipeline transportation, ensuring the resilience and efficiency of this critical infrastructure

One Nation, One Gas Grid

- The planning and operation of the Indian Power system are organized into five regional grids. The concept of **"One Nation, One Gas Grid"** entails the integration of these regional grids, creating a unified National Grid.
- This involves diversifying energy sources, establishing a unified gas pipeline grid across the nation, and ensuring the accessibility of affordable fuel for both the public and industrial sectors.
- This National Grid aims to efficiently distribute energy generated from natural gas to diverse stakeholders, including the central government, state governments, as well as both public and private sectors.
- The Prime Minister of India has inaugurated a 450-km natural gas pipeline connecting **Kochi in Kerala to Mangalore in Karnataka.** In line with the government's energy roadmap, there is a strategic vision to significantly increase the share of cleaner natural gas in the country's consumption mix.

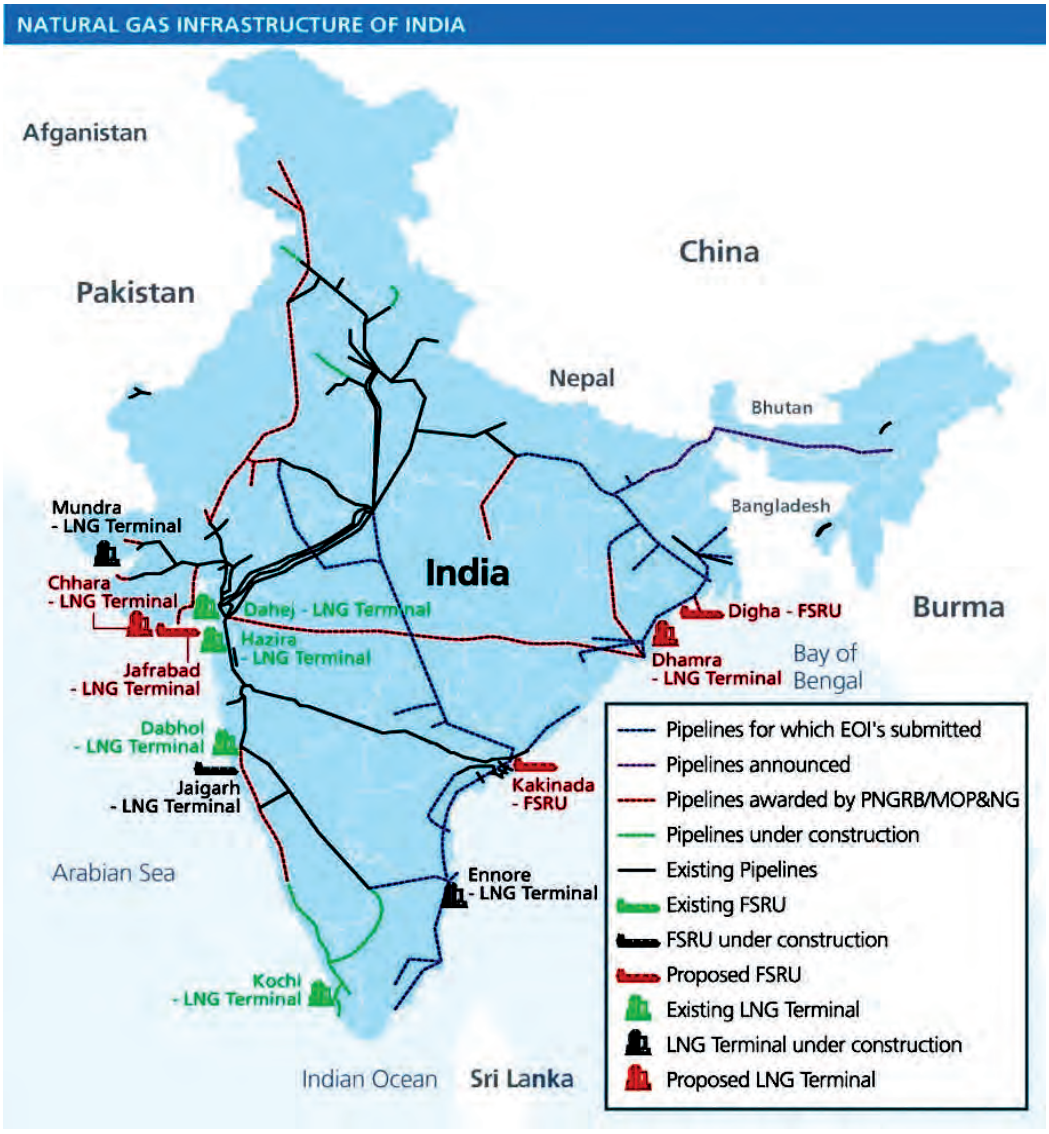


Fig. 10.18: Natural gas Infrastructure India

Objective and Need of One Nation & One Gas Grid

- **Meeting Energy Mix Targets:** Facilitates the achievement of the **government's target of 15% natural gas in the energy mix by 2030 (current: 6.2-6.5%, global average: 23-24%).**
- **National Connectivity:** Establishes a unified national gas grid to supply energy produced from natural gas to the entire country through **a single source.**
- **Addressing Regional Imbalance:** Alleviates the regional imbalance of gas availability by extending access beyond current limited pockets.
- **Gas-Based Economy:** Positions India as a gas-based economy, fostering robust economic development and promoting environmental cleanliness.
- **Environmental Sustainability:** Supports a cleaner environment amidst depleting conventional sources, preventing deforestation and desertification associated with extensive mining.
- **Reducing Import Dependency:** Aims to decrease the 53% import dependency on natural gas by diversifying India's energy mix and promoting self-sufficiency.

India's Target-

- **Expansion Targets:**
  - Government aims to increase the natural gas grid from 17,500 kilometers to 34,500 kilometers.
  - **Progress:** Already added 450 kilometers, reaching approximately 18,000 kilometers.
- **Future Expansion Projections:**
  - Targeting an additional 16,000 kilometers within the next 4-6 years.

❑ **Regional Connectivity:**

- Historically, the north and west of India were interconnected via LNG terminals.
- Recent Initiatives: Efforts made to link eastern India with the north through the **Jagdishpur-Haldia-Bokaro-Dhamra Pipeline.**
- **PM Urja Ganga Project:** In its final stages, contributing around 3,000 kilometers to the grid.

❑ **Focus on Southern India:**

- Ongoing efforts to connect the southern part of India, expecting to add about 1,500 kilometers to the grid.

Way Forward

The forward-looking strategies for the development of India's natural gas sector encompass encouraging diverse investments, promoting awareness through education, strengthening key players, implementing market reforms, ensuring universal access, and fostering collaboration among various stakeholders.

❑ **Promoting Investment:**

- Encourage increased investment in natural gas, with a proposed division of 20% for smaller manufacturing brands and 80% for government and larger companies.
- **Significance:** Investing in natural gas translates to a cleaner environment, improved public health, and economic growth through job creation.

❑ **Educational Initiatives:**

- Prioritize education about the natural gas economy to address the existing lack of knowledge.
- **Importance:** Enhancing awareness contributes to informed decision-making and support for a natural gas-based economy.

❑ **Strengthening Empowered Vehicles:**

- Strengthen organizations like GAIL, ONGC, etc., to eliminate natural gas energy poverty.
- Emphasis on key players: **Give importance to companies like ONGC for upstream gas, GAIL India for midstream production and distribution, and Oil India for oil distribution.**
- Need for Expansion: Promote the establishment of more LNG terminals to support increased upstream gas production.

❑ **Natural Gas Democracy:**

- Ensure that the benefits of natural gas are accessible to every citizen, reaching each household.
- Inclusivity: Aim for a natural gas democracy where no one is excluded from the advantages it brings.

These initiatives align with India's broader goal of expanding its natural gas infrastructure to enhance connectivity, promote energy accessibility, and achieve a more balanced distribution across regions.

Do You Know?

GAIL (India) Ltd. was founded in 1984 as a public-sector enterprise to transport, treat, and sell natural gas for commercial usage. GAIL (India) built the first 1,700 km long Hazira-Vijaipur Jagdishpur (HVJ) cross-country gas pipeline.

Role of Transportation in boosting Regional Growth

Transportation development has been a crucial driver of regional growth and economic development worldwide. By improving accessibility and reducing the cost of moving goods and people, transportation projects can lead to significant economic, social, and environmental benefits. Here, we'll explore a few case studies and examples at both national and international levels to illustrate the impact of transportation development on regional growth.

1. **Golden Quadrilateral, India:**
   - **Economic Development:** Reduced travel costs, increased trade, and investment.
   - **Industrial Growth:** Emergence of industrial clusters and Special Economic Zones.
   - **Rural Development:** Improved market access, better prices for agricultural produce.
   - **Employment:** Job creation in construction and subsequent industrial growth.
2. **Panama Canal Expansion (2016):**
   - **Global Trade Efficiency:** Reduced travel time and costs for cargo ships.
   - **Economic Benefits for Panama:** Increased toll revenues, boosted economy.
   - **Regional Trade Dynamics:** Enhanced maritime trade flows, improved port competitiveness.
3. **Nord Stream Pipeline:**
   - **Objective:** Diversify Europe's energy supply, enhance energy security.
   - **Impact:** Reliable natural gas supply, reduced geopolitical risks.
   - **Economic Benefits:** Supports growth, creates jobs, and stimulates economic activity.
4. **Rhine River's Role in European Regional Development:**
   - **Economic Growth:** Drives trade, industry, and tourism in cities like Rotterdam and Mannheim.
   - **Infrastructure Development:** Navigability enhancements through locks and dams, contributing to renewable energy.
   - **Environmental Sustainability:** ICPR-led efforts improve water quality, restore ecosystems, and manage floods.

These case studies underscore transportation's ability to catalyze economic development, enhance competitiveness, and promote sustainable regional integration.

IGNITE YOUR MIND

Green Logistics Revolution: Explore the potential of electric vehicles, hydrogen fuel cells, and intermodal transportation to decarbonize the logistics sector and promote sustainable supply chains.

Decarbonization of Transportation

- **Definition:** Reducing or eliminating CO_2 and greenhouse gas emissions in transportation is "**decarbonizing transportation**."
  - **Examples:** Electric cars, alternative fuels, energy efficiency, investments in active and public transportation.
- **Current Scenario:** India's transport sector contributes **14–15%** of national greenhouse gas emissions, with a **90%** share from road transportation. Goal: Achieve **zero emissions** by 2070.

Government Initiatives

- "**Forum for Decarbonizing Transport**" launched in August 2021.
- Collaboration with **WRI, India**, and **NITI Aayog** under NDC-TIA project.
- Focus on **policy framework** and multi-stakeholder platform for decarbonizing transport.

Strategies

- **FAME India Scheme (2015)** for electric and hybrid vehicles.
- Enhanced **FAME II scheme**.
- **PLI scheme** for ACC battery storage.
- **Railways committed** to net-zero emissions by 2030.

Focus Areas:

- Embrace **innovation**.
- Develop **infrastructure**.
- Collaborate for resilient and efficient transportation, fostering **economic growth**, **environmental sustainability**, and societal well-being.

Communication in India

The Indian postal system is the largest in the world. It takes care of both packages and letters written by hand. First-class mail is made up of cards and envelopes. Book packets, registered newspapers, and journals are examples of second-class mail. They are sent through surface mail, which includes both land and marine travel. Six postal channels were recently developed to assist faster delivery of mail in big towns and cities. They are known as the Rajdhani Channel, the Metro Channel, the Green Channel, the Business Channel, the Bulk Mail Channel, and the Periodical Channel.

Personal Communication System

The Internet is the most effective and advanced personal communication method available. It is commonly used in cities. It allows the user to make direct contact via email in order to gain access to the world of knowledge and information. It is increasingly being used for e-commerce and financial activities. The internet serves as a massive central data bank, including extensive information on a variety of subjects.The network, via the Internet and e-mail, allows efficient access to information at a cheap cost.

Mass Communication System

- **Radio:** The **Radio Club of Bombay** established radio transmission in India in 1923. Since then, it has grown in popularity and has transformed people's social lives. It immediately became a part of every family across the country.In 1930, the government capitalised on this popular means of communication by establishing the Indian Broadcasting System. In 1936, it was renamed All India Radio, and in 1957, it was renamed **Akashwani.**
- **Television (T.V.):** Television has emerged as the most effective audio-visual medium for distributing information and teaching the general public. Initially, television services were only available in the National Capital, where they debuted in 1959. Several additional centres opened their doors after 1972. In 1976, television was separated from All India Radio (AIR) and given its own identity as Doordarshan (DD). After INSAT-IA (National Television-DD1) became operational, **Common National Programmes (CNP)** were launched for the whole network, and its services were expanded to rural regions that were previously unreachable.

Do You Know?

Digital India is a broad initiative aimed at preparing India for a knowledge-based change. The goal of the Digital India Programme is to be transformational in order to realise - IT (Indian Talent) + IT (Information Technology) = IT (India Tomorrow) and to make technology key to enabling change.

Satellite Communication

This communication system is very important for the country because it uses satellites to give a continuous and clear picture of a larger area. Satellite pictures are used to predict the weather, keep an eye on natural disasters, keep an eye on the border, and do other things. After the **Indian Space Research Organization (ISRO) was founded in 1969**, satellite communication became a new way for our country to talk to each other.

Satellite System In India

- **The Indian National Satellite System (INSAT):** The INSAT, which was founded in 1983, is a multifunctional system for communications, meteorological monitoring, and other activities. The INSAT series relays signals to television, telephone, radio, and mobile phones. It may

also be used for weather sensing, the internet, and military purposes.

- **The Indian Remote Sensing Satellite System (IRS):** India's remote sensing program was created with the goal of using space technology for the benefit of humanity and the country's growth.

Three key functions were developed as a component of the project.

- First step was to design, construct, and launch satellites into Sun-synchronous orbit.
- Second step was to establish and operate ground stations for controlling spacecraft, sending data, processing data, and storing data.
- Last step was to use the data collected in different ways on the ground.

The Indian Regional Navigation Satellite System (IRNSS)

- **Regional Coverage:** IRNSS is designed to provide accurate positioning and timing information over the Indian region and a surrounding area extending up to 1500 kilometers beyond its borders.
- **Constellation:** The IRNSS constellation comprises a total of seven satellites, including three in geostationary orbit (GEO) and four in geosynchronous orbit (GSO), ensuring continuous coverage and redundancy.
- **Dual-Frequency System:** IRNSS operates on two frequency bands, namely L5 (1176.45 MHz) and S-band (2492.028 MHz), enabling better accuracy and reliability, especially in challenging environments like urban canyons and dense foliage.
- **Navigation Services:** IRNSS offers various navigation and timing services to users, including Standard Positioning Service (SPS) for civilian applications and Restricted Service (RS) for authorized users like defense and government agencies, ensuring security and integrity.
- **Indigenous Technology:** IRNSS showcases India's capability in space technology, with its satellites, ground infrastructure, and user equipment being developed indigenously, reducing dependency on foreign systems.
- **Integration with Global Navigation Satellite Systems (GNSS):** IRNSS is designed to be interoperable and compatible with other global navigation systems like GPS, GLONASS, and Galileo, providing users with enhanced positioning accuracy and availability.
- **Applications:** IRNSS finds applications in various sectors such as transportation, agriculture, disaster management, surveying, and defense, facilitating precise navigation and timing information for diverse user needs.

Overall, IRNSS stands as a testament to India's advancements in space technology, offering an independent and reliable navigation solution tailored to the needs of the Indian region.

Postal Communication

- Postal services are involved in the delivery of many types of communication such as letters, telegrams, and telegrams. In addition to these services, the post office offers some financial services as well as the processing of postal orders and money orders.
- The **Department of Post,** which is part of the **Ministry of Communications,** operates the postal service in India under the trade name **India Post**. It is the most frequently used postal system in the entire globe and is commonly referred to as the Post Office.
- Indian postal services are governed by the Indian Post Office Act of 1898. India's postal network has grown from 23,344 to 1,55,035, with 1,39,173 in rural areas. The network of post is of four divisions: Head Post Offices, Sub Post Offices, Extra Departmental Sub Post Offices, and Extra Departmental Branch Post Offices.

Key Challenges in India's Communication System

India's communication system has seen rapid growth, yet faces critical challenges that need addressing to ensure equitable access and quality for all.

- **Infrastructure Disparities:** A stark contrast in connectivity between urban and rural areas limits the reach and effectiveness of communication services.
- **Quality of Service Issues:** Users often face problems such as call drops, inconsistent internet speeds, and limited bandwidth.
- **Affordability:** High costs of digital devices and internet services remain a barrier for a significant portion of the Indian population.
- **Digital Literacy:** A lack of digital literacy across various demographics hinders the full utilization of digital technologies.
- **Cybersecurity Concerns:** Increasing cyber threats and data security issues pose risks to users' privacy and national security.

To harness the full potential of its communication system, India must focus on bridging the digital divide, enhancing service quality, improving affordability, boosting digital literacy, and strengthening cybersecurity measures.

Way Forward

- **Infrastructure Development:** Invest in expanding and upgrading communication infrastructure, particularly in rural and remote areas, to ensure equitable access to quality services.
- **Quality Assurance Measures:** Implement stricter regulations and monitoring mechanisms to improve the quality of communication services, reducing instances of call drops and internet connectivity issues.
- **Affordability Initiatives:** Introduce subsidies, incentives, and innovative pricing models to make digital devices and internet services more affordable for all segments of society.

- **Digital Literacy Programs:** Launch widespread digital literacy campaigns and training programs to empower individuals with the skills needed to effectively use digital technologies and access online resources.
- **Cybersecurity Enhancements:** Strengthen cybersecurity frameworks, promote awareness about online safety practices, and invest in robust cybersecurity infrastructure to mitigate cyber threats and safeguard user data.
- **Public-Private Partnerships:** Foster collaboration between government agencies, private sector entities, and civil society organizations to implement comprehensive solutions and initiatives aimed at improving India's communication ecosystem.

By adopting these strategic measures, India can address the challenges in its communication system and pave the way for a more inclusive, accessible, and resilient digital infrastructure that benefits all citizens.

In conclusion, addressing the challenges in India's communication system is imperative for fostering inclusive digital growth and enhancing socio-economic development. Strategic investments, policy reforms, and collaborative efforts are key to building a robust, accessible, and secure communication infrastructure that meets the diverse needs of the Indian populace.

IGNITE YOUR MIND

Digital Divide and Trade Inequalities: How can we bridge the digital divide between developed and developing countries to ensure equitable access to trade opportunities and benefits in the globalized world?

International Trade

International trade involves the cross-border exchange of goods, services, and capital, fostering economic integration. It operates on the principle of comparative advantage, where countries specialize in what they produce efficiently. Trade is influenced by various policies, and global agreements shape the landscape, promoting economic growth and interdependence.

History of International Trade

- **Ancient Roots:** Dates back to Mesopotamia and the Indus Valley, evidenced by archaeological trade route findings.
- **Silk Road:** Established circa 200 BCE, connecting East Asia to the Mediterranean for silk, spice, and commodity exchange.
- **Age of Exploration:** 15th-17th centuries saw European powers exploring new trade routes, with Christopher Columbus opening transatlantic trade.
- **Colonial Era:** Colonization intensified global trade, as European powers extracted resources from colonies.
- **Industrial Revolution:** 18th-century industrial expansion increased production and demand, fueling global trade.
- **Post-World War Era:** GATT in 1947 laid the foundation for modern international trade rules after World War II.
- **WTO Formation:** WTO succeeded GATT in 1995, promoting global free trade and resolving disputes.

Foundations and Dynamics of International Trade

International trade operates on the Theory of Comparative Advantage. David Ricardo's theory advocates nations specializing in efficient areas, fostering mutual benefits through trade. It asserts that, even if one country excels in all aspects, both gain by specializing in their respective efficient areas.

Key Influences on International Trade

- **Comparative Advantage:** Drives global trade by leveraging unique production efficiencies.
- **Resource Endowments:** Countries specialize based on abundant resources, e.g., oil-rich nations focusing on related industries.
- **Labor Costs:** Variances influence trade patterns; lower-cost countries attract labor-intensive industries.
- **Technological Advancements:** Innovations, like containerization, enhance efficiency, reducing transportation costs.
- **Trade Balances:** Nations seek positive balances, impacting economies differently with surpluses or deficits.
- **Trade Policies:** Governments use tariffs, subsidies, and agreements to shape trade, protect industries, or boost exports.
- **Global Supply Chains:** Modern economies rely on intricate global supply chains, emphasizing global production and trade.

Recent Trade Data and Trends

- Global merchandise exports reached $21.6 trillion in 2020, impacted by the COVID-19 pandemic.
- Services exports were valued at around $5.7 trillion in the same period.
- China, a dominant trading nation, forms significant partnerships with the U.S., EU, and Japan.
- The EU represents a major trading bloc, fostering extensive internal and global trade among member states.

These elements highlight the multifaceted nature of international trade, shaped by economic theories, resource dynamics, labor considerations, technological advancements, policy decisions, and global supply chains.

Ports

Ports play diverse roles in global trade. From industrial and commercial hubs to specialized oil ports, inland ports, and comprehensive facilities, each type serves a unique purpose. Out ports support primary ones, while packet stations and ports of call, with historical significance, add depth to maritime connectivity.

Entrepot ports thrive on trade, and naval ports focus on military operations. This concise exploration offers insights into the varied functions of ports, particularly within the context of India's maritime landscape.

Type of Ports	Description	Examples in India	Data/Facts
Industrial Ports	Designed for industrial purposes, handling bulk cargo and raw materials.	**Mundra Port, Gujarat**	India's largest private port, handling significant portions of the country's container traffic.
Commercial Ports	Focus on facilitating trade and commerce, handling various types of cargo.	**Nhava Sheva (Jawaharlal Nehru Port), Maharashtra**	India's largest container port, handling about half of the container cargo in the country.
Comprehensive Ports	Versatile ports accommodating multiple functions, from trade to industrial activities.	**Kolkata Port (Syama Prasad Mookerjee Port), West Bengal**	India's only riverine port, with facilities for cargo handling, storage, and processing.
Inland Ports	Located on inland waterways, providing access to trade routes for landlocked regions.	**ICD Tughlakabad, New Delhi**	One of the largest inland container depots, facilitating trade for the northern region.
Out Ports	Secondary ports support larger main ports by handling overflow and specific cargo.	**Kattupalli Port, Tamil Nadu**	Acts as an out port to Chennai Port, focusing on container handling and automotive exports.
Oil Ports	Specialized in handling petroleum and oil-related products.	**Jamnagar Port, Gujarat**	Home to the world's largest oil refining complex, handling vast quantities of crude oil.
Port of Call	Ports visited by vessels for loading/unloading, fueling, or repairs during a journey.	**Kochi Port, Kerala**	A major port of call, especially for cruise liners and the Indian Navy.
Packet Station	Mostly historical, served packet ships for mail and passenger transport.	**Liverpool, United Kingdom (World Context)**	Historically, Liverpool served as an important packet station for transatlantic mail and passengers in the 19th century.
Entrepot Ports	Ports functioning as trade and storage hubs, facilitating re-exportation.	**Chennai Port, Tamil Nadu**	Acts as a crucial entrepot for the southeastern region, handling diverse cargoes.
Naval Ports	Ports designated for military naval operations and maintenance.	**Visakhapatnam Port, Andhra Pradesh**	Hosts a significant naval base alongside its commercial operations.

World Trade Pattern

The world trade pattern refers to the global distribution of trade flows among countries and regions. It is influenced by various factors such as economic development, comparative advantage, technological advancements, and government policies. Here are some key points to provide a brief idea about the world trade pattern:

- **Globalization and Interconnectedness:** The world trade pattern reflects the increasing interconnectedness of economies, with countries engaging in cross-border transactions of goods and services.
- **Major Players and Partnerships:** Key participants in global trade include the United States, China, the European Union, and Japan. Regional trade blocs, such as NAFTA, the EU, and ASEAN, play pivotal roles in shaping trade dynamics.
- **Supply Chains and Specialization:** Global supply chains are integral, with countries specializing in the production of specific goods or components. This specialization contributes to the assembly and processing of goods across borders.
- **Technological Advancements and E-commerce:** Advances in technology, transportation, and communication have facilitated the expansion of global trade. E-commerce has emerged as a significant driver, influencing how goods and services are exchanged internationally.
- **Trade Imbalances and Economic Development:** Trade imbalances, with some countries running surpluses and others deficits, reflect different economic development levels. Developed nations often trade in high-value-added goods, while developing countries may focus on raw materials and labor-intensive products.

- **Government Policies and Global Events:** Trade patterns are influenced by government policies such as tariffs, trade agreements, and barriers. Global events like recessions, pandemics, and geopolitical tensions can disrupt trade flows and reshape the world trade pattern.
- Understanding the world trade pattern involves considering these various factors, as they collectively shape the complex and dynamic landscape of international trade. Data on trade volumes, export-import ratios, and trade balances provide insights into these patterns, and organizations like the World Trade Organization (WTO) and the International Monetary Fund (IMF) often release reports and statistics to track global trade trends.

Recent Context

- According to the **World Trade Organization (WTO),** global merchandise trade registered a 5.3% increase in 2021 after a 5.3% decline in 2020, showcasing the resilience and recovery of international trade following the disruptions caused by the COVID-19 pandemic.
- The WTO also notes that trade tensions, geopolitical factors, and the unequal distribution of vaccines can pose risks to the continued growth of overseas trade.
- In recent years, e-commerce has seen substantial growth in international trade. The ease of online transactions has enabled small and medium-sized enterprises to participate more actively in global markets.

Major Oceanic Trade Routes

Major oceanic trade routes have been pivotal in shaping global trade, fostering economic development, and facilitating cultural exchange for centuries. These routes, traversing the world's oceans, connect major commercial hubs and ports across continents. Here's a brief overview of some key oceanic trade routes, highlighting their significance and examples:

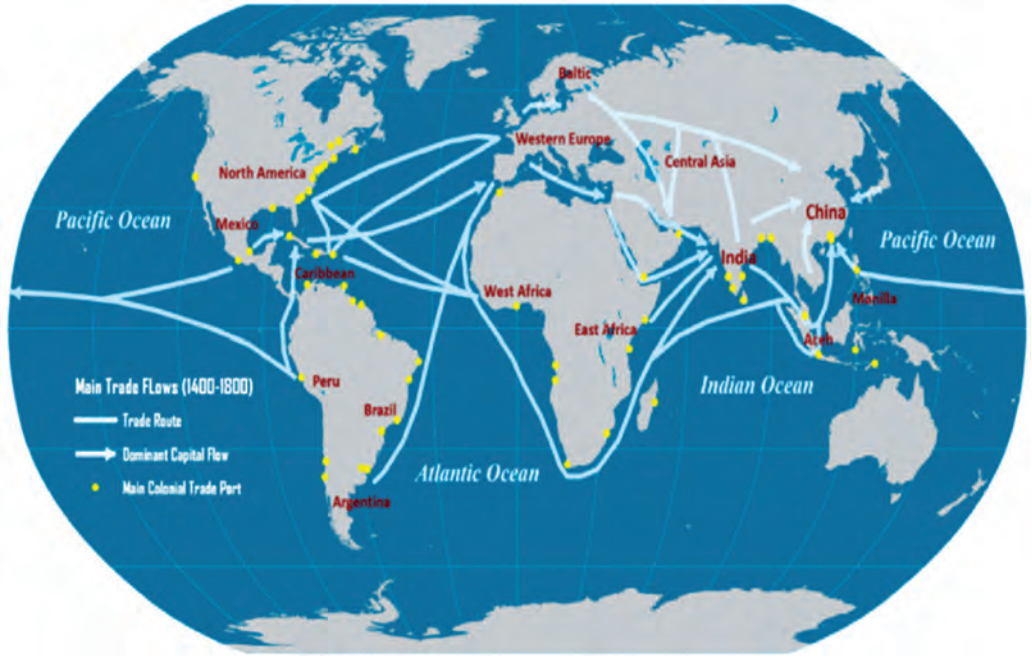


Fig. 10.19: Major Oceanic Trade Routes

- **Panama Canal Route:** Links Pacific and Atlantic Oceans, offering a shorter and safer passage for East-West Americas trade, handling 5% of global oceanic trade.
- **Suez Canal Route:** Essential maritime shortcut, connecting Mediterranean and Red Seas, crucial for oil and natural gas shipments.
- **Strait of Malacca:** Key chokepoint linking Pacific and Indian Oceans, major shipping channel for goods, especially oil, between Persian Gulf and Asian markets.
- **North Atlantic Trade Route:** Crucial link between North American and European ports, facilitating exchange of goods, playing a significant role in EU-USA economic relations.
- **Trans-Pacific Route:** Connects Asia with North and South America, vital for exchange of electronic goods, vehicles, machinery, and agricultural products.
- **Cape of Good Hope Route:** Historically important, significant for ships unable to pass through Suez Canal, especially for bulk commodities like oil and coal, offering an alternative route between Atlantic and Indian Oceans.

These routes not only underscore the globalization of trade but also highlight the strategic importance of certain waterways where geopolitical interests often intersect. The volume of trade on these routes is staggering, with billions of tons of cargo moved annually, underscoring the global economy's reliance on efficient and secure maritime trade pathways.

India's Foreign Trade

According to a study by the **Global Trade Research Initiative (GTRI),** exports of goods and services rose by 1.5% from January to June of 2023 to USD 385.4 billion, up from USD 379.5 billion during the same period in 2022. The report says that India's international trade (exports and imports of goods and services) was worth USD 800.9 billion from January to June 2023. This is down 2.5% from the same time last year (January to June 2022).

Trends in India's Foreign Trade

1. India's overall exports (Merchandise and Services combined) in December 2023 is estimated to be USD 66.33 Billion, exhibiting a negative growth of (-) 4.25 per cent over December 2022.

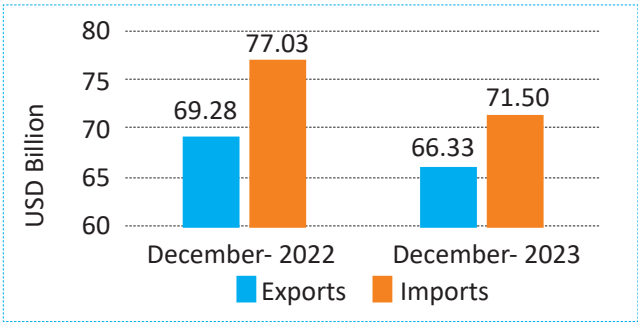


Fig 10.20: Export-Import India

2. Overall imports in December 2023 is estimated to be USD 71.50 Billion, exhibiting a negative growth of (-) 7.18 per cent over December 2022.
3. India's merchandise exports in December 2023 registered 0.96% growth at USD 38.45 Billion over USD 38.08 Billion in December 2022.

Category	December 2023 (USD Billion)	December 2022 (USD Billion)
Merchandise Exports	38.45	38.08
Merchandise Imports	58.25	61.22
Services Exports	27.88	31.19
Services Imports	13.25	15.81
Overall Trade (Merchandise + Services Exports)	66.33	69.28
Overall Trade (Merchandise + Services Imports)	71.50	77.03
Trade Balance	-5.17	-7.75

IGNITE YOUR MIND

Fair Trade vs. Free Trade: Analyse the merits and drawbacks of fair trade and free trade agreements, considering their impact on developing economies, labor rights, and environmental sustainability. Explore the potential of blockchain technology to improve transparency and traceability in supply chains, combating counterfeiting and promoting ethical trade practices.

Composition of Indian Trade

The composition of Indian trade encompasses a diverse range of goods and services that India exports to and imports from the global market. This composition reflects India's economic priorities, industrial capacities, and the evolving nature of its trade relationships

1. **Diverse Export Basket:** India exports IT services, textiles, gems, jewelry, pharmaceuticals, and agricultural goods.
2. **Major Imports:** Crude oil, precious metals, electronics, and machinery constitute significant imports.
3. **Trade Agreements:** India engages in bilateral and multilateral trade agreements, including SAFTA and partnerships with ASEAN.
4. **Export Competitiveness:** Continuous efforts to improve export competitiveness through policy reforms, infrastructure development, and ease of doing business.

Impact of Trade Liberalization on the Geographical Distribution of Industries

Trade liberalization, the process of reducing tariffs and other barriers to the import and export of goods and services, has significant impacts on the geographical distribution of industries. This shift is attributed to various factors, including comparative advantage, economies of scale, and access to larger markets. Here's a brief overview with relevant facts and data:

1. **Impact on Comparative Advantage**
   - Trade liberalization allows countries to specialize in industries where they have a comparative advantage, leading to a geographical concentration of certain industries.
   - For instance, the **North American Free Trade Agreement (NAFTA)** led to Mexico specializing in labor-intensive manufacturing industries such as automobiles and textiles, leveraging its lower labor costs. The U.S. and Canada, in contrast, focused more on capital-intensive and high-technology industries.
2. **Economies of Scale**
   - Opening up to international trade encourages firms to expand to serve global markets, leading to economies of scale. This often results in industry

clustering in specific regions to maximize production efficiency and minimize transportation costs.

- The European Union's single market has facilitated such clustering, particularly in high-value manufacturing and services sectors within central and western Europe.

3. **Access to Markets and Resources**
   - Trade liberalization provides industries with access to a broader range of markets and resources, influencing their geographical distribution.
   - For example, the **ASEAN Free Trade Area (AFTA)** has enhanced intra-regional trade, leading to the development of integrated supply chains across Southeast Asia. This integration has promoted the growth of manufacturing hubs in countries like Vietnam and Thailand, which are strategically located to serve both the ASEAN and global markets.
4. **Impact on Developing Countries**
   - Developing countries often experience a shift towards industries in which they have a natural resource or labor cost advantage. After liberalizing trade, countries such as India and Bangladesh have seen a significant growth in their textile and garment industries, benefiting from access to global markets.
   - Bangladesh, for example, became the world's second-largest apparel exporter due to its competitive labor costs, with the garment industry now accounting for over 80% of its total exports.

Challenges and Adjustments

While trade liberalization can lead to industry growth and economic benefits, it also requires adjustments. Industries that are not competitive may shrink, leading to job losses in certain regions.

For instance, the United States has seen a decline in manufacturing jobs in traditional sectors such as steel and textiles, partly due to increased competition from imports. This has necessitated policy responses to support retraining and relocation of affected workers.

Trade liberalization has a profound impact on the geographical distribution of industries, promoting industry specialization based on comparative advantages, economies of scale, and access to markets and resources. However, the benefits are not uniformly distributed, necessitating policies to mitigate negative impacts on less competitive sectors and regions. The ongoing evolution of global trade agreements and digital technology continues to shape the dynamics of industry distribution across the globe.

Regional and Multilateral Trading Blocks

Regional and multilateral trading blocs are instrumental in shaping global trade dynamics by fostering cooperation among countries to reduce trade barriers and promote economic integration. These agreements aim to facilitate smoother trade flows, enhance market access, and stimulate economic growth by pooling resources and leveraging collective bargaining power.

Examples include regional blocs like the European Union (EU) and multilateral organizations such as the World Trade Organization (WTO), which play pivotal roles in governing international trade relations and setting standards for trade practices on a global scale.

- **European Union (EU):** A political and economic union of 27 European countries that have eliminated trade barriers among themselves.
- **North American Free Trade Agreement (NAFTA)/ USMCA (United States-Mexico Canada Agreement):** A trade agreement between Canada, Mexico, and the United States to reduce tariffs and increase trade between the member countries.
- **Association of Southeast Asian Nations (ASEAN):** A regional intergovernmental organization comprising ten Southeast Asian countries, which promotes intergovernmental cooperation and facilitates economic, political, security, military, educational, and sociocultural integration among its members and other Asian states.

TOURISM

Defined by the **World Tourism Organization**, tourism is a multifaceted phenomenon with social, cultural, and economic implications. It involves the movement of individuals to countries or places outside their usual environment, both for personal and business/professional reasons.

In the Modern era, tourism has gained prominence as a crucial socio-economic phenomenon, often treated as an industry due to its capacity to generate numerous social and economic benefits. India, with its exceptional diversity and cultural richness, situated between the majestic Himalayas in the north and stunning beaches in the south, offers significant tourism potential. Tourism has evolved from its origins in learning and studying to encompass various leisure activities, including cultural exploration and enjoying natural beauty. Today, it is considered a significant industry with substantial socio-economic benefits. India, with its diverse attractions, is poised to benefit from the growth of this sector.

SDG And Tourism

In the 2030 Agenda for Sustainable Development **SDG Target 8.9**, aims to "by 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products". The importance of sustainable tourism is also highlighted in **SDG target 12.b.** which aims to "develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products".

Tourism Industry in India

The tourism industry in India is a significant contributor to the country's economy and employment. It offers various

attractions and experiences for domestic and international visitors, such as heritage, culture, nature, adventure, wellness, and more.

Tourism Industry in India: Stats

- Before the onset of the pandemic, the contribution of the tourism sector to India's GDP had reached ~US$ 250 billion in 2018. However, the contribution had fallen to US$ 122 billion in 2020 due to the pandemic. The share of Tourism to GDP has hovered around ~5-6%. With post-pandemic recovery, the tourism industry is expected to reach US$ 512 billion by 2028.
- Tourism generated ₹13.2 lakh crore (US$170 billion) or 5.8% of India's GDP and supported 32.1 million jobs in 2021.
- India ranks 6th according to World Travel & Tourism Council (WTTC) in terms of Travel & Tourism total contribution to GDP in 2022.
- India has established itself as the 5th largest global travel healthcare destination with an estimated market size of around $9 billion in 2019.
- India has been ranked 54th in the **Travel & Tourism Competitiveness Index 2021** by the World Economic Forum.
- **Foreign Tourist Arrivals:** Foreign Tourist Arrivals (FTAs) in March 2022 were 3,42,308 with a positive growth rate of 177.9 per cent as compared to 1,23,179 in March 2021. FTAs during the period January- March 2022 were 7,84,750.
- **Kerala was named as one of the "ten paradises of the world"** and "50 must see destinations of a lifetime" by National Geographic's Traveller magazine.

Some of the factors that have boosted the prospects of the tourism industry in India:

- The government's initiatives to promote tourism, such as the **e-visa scheme, the Incredible India campaign, the Swadesh Darshan scheme, and the PRASAD scheme.**
- The increasing disposable income and travel aspirations of the middle class, especially the young and urban population.
- The emergence of new segments of tourism, such as medical tourism, rural tourism, cruise tourism, and MICE tourism.
- The development of infrastructure, connectivity, and hospitality facilities across the country.
- The growing awareness and recognition of India's tourism potential in the global market.

WEF Travel and Tourism Development Index

In the WEF Travel and Tourism Development Index 2021, India has been ranked at 54th place. The WEF's Travel and Tourism Development Index 2021 is a direct evolution of the Travel & Tourism Competitiveness Index, which has been published biennially for the past 15 years. The Index assesses 117 economies, based on 5 subindexes, 17 pillars and 112 individual indicators, distributed among the different pillars.

Tourist circuits in India

India is a vast and diverse country with something to offer everyone. There are many different tourist circuits that you can take, depending on your interests. Here are a few of the most popular:

- **The Golden Triangle Circuit**: This is one of the most famous and luxurious tourism circuits in India, covering Delhi, Agra, and Jaipur. It showcases the architectural marvels, historical monuments, and cultural diversity of India's capital, the Mughal city of Agra, and the royal city of Jaipur.
  - Some of the attractions along this circuit are the India Gate, the Red Fort, the Qutub Minar, the Taj Mahal, the Fatehpur Sikri, the Agra Fort, the Jantar Mantar, the Hawa Mahal, the City Palace, and the Amer Fort.
- **The Nilgiri Circuit**: This is a scenic and relaxing tourism circuit that covers Bangalore, Mysore, and Ooty in the Nilgiri hills. It offers a glimpse of the urban life, the royal heritage, and the natural beauty of South India.
  - Some of the attractions along this circuit are the Cubbon Park, the Bangalore Palace, the Devanahalli Fort, the Lal Bagh, the Bannerghatta National Park, the Mysore Palace, the Folklore Museum, the Melody World Wax Museum, the Mysore Zoo, the Emerald Lake, the Avalanche Lake, the Government Rose Garden, and the Doddabetta Peak.
- **The Backwaters Circuit**: This is a serene and romantic tourism circuit that covers Alleppey, Kochi, and Kumarakom in Kerala. It offers a chance to explore the tranquil and picturesque backwaters of Kerala, which are a network of lakes, canals, and lagoons parallel to the Arabian Sea.
  - Some of the attractions along this circuit are the houseboat cruises, the paddy fields, the coconut groves, the fishing villages, the Chinese fishing nets, the Fort Kochi, the Mattancherry Palace, the Jewish Synagogue, the Kumarakom Bird Sanctuary, and the Vembanad Lake.
- **The Chota Char Dham Circuit**: This is a sacred and adventurous tourism circuit that covers Badrinath, Kedarnath, Gangotri, and Yamunotri in the Himalayas. It offers a pilgrimage to the four holy sites associated with Hindu culture and spirituality.
  - Some of the attractions along this circuit are the Badrinath Temple, the Kedarnath Temple, the Gangotri Glacier, the Yamunotri Temple, the Hemkund Sahib, the Valley of Flowers, Haridwar, and Rishikesh.
- **The Sufi Circuit**: This is a spiritual and cultural tourism circuit that covers Delhi, Agra, and Jammu & Kashmir. It offers a glimpse of the mystical and musical traditions of Sufism, which is a form of Islamic mysticism and devotion.
  - Some of the attractions along this circuit are the Nizamuddin Dargah, the Qutub Minar, the Humayun's Tomb, the Taj Mahal, the Fatehpur Sikri, the Agra Fort, the Hazratbal Shrine, the Charar-e-Sharif, the Shankaracharya Temple, and the Dal Lake.

Fig. 10.21: Major Tourist Circuits in India

- **The Ramayana Circuit:** This is a religious and cultural tourism circuit that covers the major pilgrim sites in India and Nepal that are related to the era of Ramayana, such as Ayodhya in Uttar Pradesh, where a temple is being built for Lord Ram as well as Janakpur in Nepal, which is believed to be the birthplace of Sita, the consort of Lord Ram.
  - Some of the attractions along this circuit are the Ram Janmabhoomi, the Hanuman Garhi, the Ramkot, the Kanak Bhawan, the Nageshwarnath Temple, the Guptar Ghat, the Shringverpur, the Chitrakoot, the Sitamarhi, the Buxar, the Darbhanga, the Nandigram, the Mahendragiri, the Jagdalpur, the Bhadrachalam, the Hampi, and the Rameshwaram.
- **The Krishna Circuit:** This is a spiritual and historical tourism circuit that covers the places associated with the life and legends of Lord Krishna, one of the most revered deities in Hinduism.
  - Some of the attractions along this circuit are the Dwarka in Gujarat, where Krishna established

his kingdom; the Nathdwara, the Jaipur, and the Sikar in Rajasthan, where Krishna is worshiped as Shrinathji; the Kurukshetra in Haryana, where Krishna delivered the Bhagavad Gita to Arjuna; the Mathura, the Vrindavan, the Gokul, the Barsana, the Nandgaon, and the Govardhan in Uttar Pradesh, where Krishna was born and spent his childhood; and the Puri in Odisha, where Krishna is worshiped as Jagannath.

Factors Affecting Tourism Industry

- **Economic factors**: The GDP, income levels, exchange rates, and demand and supply of tourism services affect the affordability and attractiveness of tourism in India. For example, a strong Indian rupee makes it more expensive for foreign tourists to visit India, while a weak rupee makes it cheaper for Indians to travel abroad.
- **Security factors**: The stability, security, and policies of the government affect the confidence and safety of tourists in India. For example, natural disasters can deter tourists from visiting certain regions or destinations in India, while visa regulations, tax incentives, or infrastructure development can facilitate tourism growth.
- **Social factors**: The demographic, cultural, and lifestyle changes of the population affect the preferences and expectations of tourists in India. For example, an aging population may demand more accessible and comfortable tourism services, while a younger generation may seek more adventurous and experiential tourism products.
- **Environmental factors**: The natural and man-made resources, attractions, and amenities of India affect the quality and diversity of tourism in India. For example, the climate, geography, wildlife, heritage, and festivals of India offer a rich and varied tourism experience, while the pollution, congestion, degradation, and conservation of these resources affect the sustainability and attractiveness of tourism in India

MEDICAL TOURISM

Medical tourism, also known as medical travel, health tourism, or global healthcare, refers to the growing practice of individuals travelling across international borders to access healthcare services. This includes a wide range of services, from elective procedures to complex surgeries.

- The Indian medical tourism industry was estimated to be valued at US$ 7,417 million in 2022. India is ranked 10th out of the top 46 countries in the world in the Medical Tourism Index 2020-21 by Medical Tourism Association.
- This not only generates revenue and employment for hospitals but also enhances India's soft power, positioning it as a global healing hub. The majority of medical tourists come from Asian and African countries, including Sri Lanka, Bangladesh, Nepal, Maldives, Indonesia, and Kenya.
- The Indian government has also introduced **Wellness Tourism,** leveraging the country's ancient wisdom in wellness systems like Ayurveda, Yoga, Siddha, Naturopathy, and spiritual philosophy. This initiative positions India as a centre for these holistic practices.

India's Medical Tourism Appeal

- **Qualified Medical Professionals:** Internationally experienced doctors enhance India's allure.
- **Language Proficiency:** English-speaking medical staff ensures effective communication.
- **Advanced Facilities:** State-of-the-art infrastructure positions India as a preferred destination.
- **Affordability:** Cost-effective treatments offer significant savings, attracting global patients.

In conclusion, India's medical tourism thrives on skilled professionals, language proficiency, advanced facilities, and cost-effectiveness, making it a premier global healthcare destination.

"Heal In India" Initiative

- "Heal in India" is a pan-India initiative led by the Ministry of Health and Family Welfare and the Ministry of Ayush catering to global patients.
- Aim: It aims to standardize processes and treatment packages for foreign nationals, addressing price disparities in different hospitals.
- The government's goal for this initiative is to increase the medical tourism industry to $13 billion by 2026.
- The initiative is rooted in Indian philosophy, emphasising Seva (service) and Athithi Devobhava (guest is like God).
- The initiative will establish a certified central grievance redressal mechanism for international patients.
- A key component is the "Medical Value Travel" digital portal, designed to guide international patients through their entire medical journey in India and promote Indian health facilities and professionals globally.

ECOTOURISM

Ecotourism involves nature-based forms of tourism where tourists are primarily motivated by the observation and appreciation of nature and traditional cultures in natural areas.

India boasts unparalleled natural attractions, including pristine forests, the majestic Himalayas, montane grasslands, golden and silver desserts, rivers, lakes, wetlands, mangroves, beaches, volcanoes, and coral reefs, all home to incredible biodiversity. The country also hosts iconic species like tigers, lions, elephants, rhinos, leopards, wild buffaloes, Indian bison (gaur), and over 1200 species of birds.

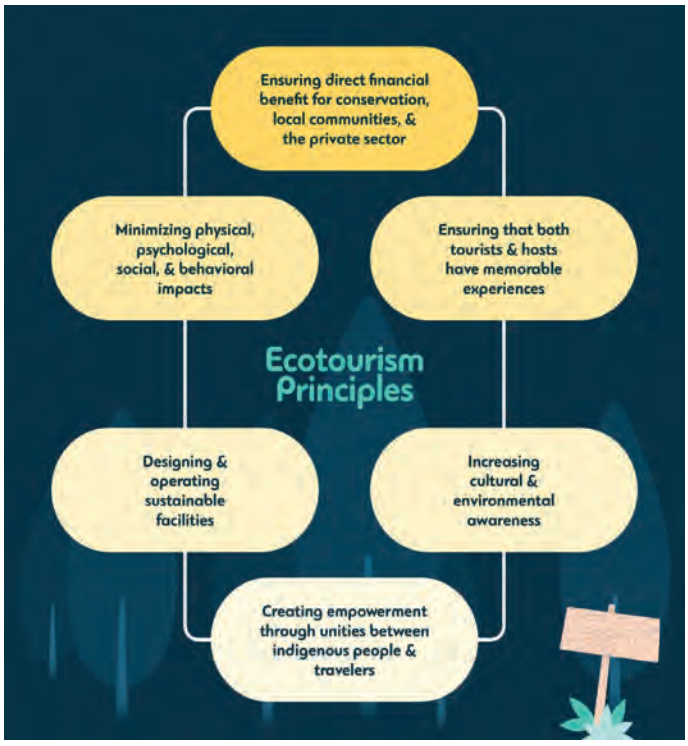

Ensuring direct financial benefit for conservation, local communities, & the private sector
Minimizing physical, psychological, social, & behavioral impacts
Ensuring that both tourists & hosts have memorable experiences
Ecotourism Principles
Designing & operating sustainable facilities
Increasing cultural & environmental awareness
Creating empowerment through unities between indigenous people & travelers

Fig. 10.22: Eco-tourism Principles

India's Potential for Ecotourism

- India has immense potential as an ecotourism destination for several compelling reasons.
- First, it boasts a staggering 70 per cent of the Himalayan region, offering breathtaking mountain landscapes, unique wildlife, and pristine environments for nature enthusiasts to explore. India's vast coastline stretches for an impressive 7,000 kilometres, providing opportunities for coastal ecotourism experiences like beachcombing, wildlife watching, and water sports.
- Also, **India is one of only three countries worldwide to feature both hot and cold deserts**. This diversity means travelers can witness the stark beauty of the Thar Desert's golden sands in the west and the high-altitude cold deserts of Ladakh in the north.
- **India ranks 10th globally in total forest cover**, ensuring ample opportunities for eco-friendly adventures like trekking, bird-watching, and exploring lush, biodiverse forests. With this India boasts an impressive collection of **7 UNESCO-recognized Natural World Heritage Sites** (Great Himalayan National Park Conservation Area, Kaziranga National Park, Keoladeo National Park, Manas Wildlife Sanctuary, Nanda Devi and Valley of Flowers National Parks, Sundarbans National Park, Western Ghats).
- This ranks India 6th globally, showcasing its commitment to preserving and showcasing its unique natural wonders. Hence India's combination of Himalayan landscapes, extensive coastline, diverse deserts, abundant forests, and a wealth of UNESCO-recognized natural sites make it a promising ecotourism destination for travellers seeking unforgettable encounters with nature.

Role of Ecotourism

Ecotourism is recognized worldwide as a potent tool for conserving forests, biodiversity, wildlife, and scenic landscapes. It accomplishes this by providing sustainable livelihoods for forest-dependent communities and by raising awareness about conservation among the general public and decision-makers.

Challenges of Ecotourism in India

- **Finding the Right Places:** Each Indian state should engage in a participatory process involving stakeholders, especially local communities, to identify potential eco-tourism sites and establish a priority list for their development. With **573 wildlife sanctuaries and 109 national parks,** India possesses immense ecotourism potential waiting to be harnessed for sustainable exploration and conservation efforts. Sikkim's ecotourism success, driven by the active involvement of local communities in activities like homestays and showcasing cultural traditions, serves as an exemplary model to replicate in the Northeast and other lesser-explored regions across India.
- **Funding Support:** The eco-tourism sector's unique challenges, such as small and geographically scattered enterprises, require specialized funding instruments to ensure sustainable promotion. Nowadays, international financial agencies have begun providing funding, and it is a significant boost to ecotourism in India. In 2023 the Government of Meghalaya secured a substantial $79.05 million grant from the New Development Bank (NDB) for the Meghalaya Ecotourism Infrastructure Development Project (MEIDP).
- **Capacity Building** The capacity-building efforts should focus on field functionaries, site managers, and local communities, enabling them to innovate and meet present and future challenges based on international best practices tailored to local conditions.
- **Monitoring:** Each eco-tourism plan must include a dynamic monitoring mechanism. This covers multiple biological parameters to assess the impact of tourist visits on wildlife, local community involvement, improvements in ecosystem services, and measures to prevent biological invasion, disease transmission, and environmental pollution, including air, water, noise, and light pollution.

By addressing these challenges, India can make ecotourism more sustainable and enjoyable for everyone.

Green Tourism

Green tourism initially referred to as small-scale tourism focused on visiting natural areas while minimizing environmental impact. However, it has evolved to encompass any tourism activity claiming to be environmentally friendly.

- **Relation with Ecotourism:** Green Tourism prioritizes sustainability, while Ecotourism focuses on nature conservation.
- **Activities:** Encompasses eco-friendly accommodations, waste reduction; Ecotourism involves wildlife observation.

Eco-Conscious Initiatives:

- **Vision:** Aims for destinations free of pollution and plastic, promoting minimal environmental harm.
- **Adoptions:** Global hotels and resorts adopting eco-conscious measures, such as energy-efficient lighting and waste reduction.
- **Certification Programs:** EarthCheck, Green Key, and LEED help travelers identify environmentally committed businesses.

Importance of Green Tourism:

- **Strategic Priority:** Goa roadmap designates Green Tourism as the top priority, aligning with COP26 targets and SDGs.
- **Benefits:** Enhances natural resource management, energy efficiency, conservation, biodiversity support, and waste reduction.
- **Opportunities:** Creates job quality, raises incomes, promotes equity, social inclusion, and supports responsible tourism.

Challenges in Green Tourism:

- **Destination Selection:** Crucial to prioritize destinations supporting local economies while preserving nature; vehicular access limitations may apply.
- Collaboration: Requires active cooperation among stakeholders, including government, local communities, NGOs, and the private sector.
- **Role of Private Sector:** Corporate initiatives are essential for sustainability; CSR funds can contribute significantly.
- **Greenwashing Concerns:** The negative reputation of businesses using green claims without genuine impact necessitates government guidelines and certifications.
- **Lack of Awareness:** Addressing awareness gaps through campaigns like "Incredible India" and early education for sustainability culture.

Green Tourism offers strategic advantages aligning with global goals, presenting economic, environmental, and social benefits. Challenges, from destination choices to private sector involvement and awareness gaps, require collaborative, government-driven solutions.

Marine Tourism in India

Marine tourism in India is a sector that offers a variety of attractions and activities for visitors who want to enjoy the beauty and diversity of the Indian coastline and islands. Some of the popular destinations for marine tourism in India are:

- **Goa:** Goa is known as the 'Pearl of the Orient' and attracts millions of tourists every year for its sandy beaches, water sports, nightlife, and cultural heritage.
- **Kerala:** Kerala is famous for its backwaters, which are a network of canals, lagoons, and lakes that offer scenic views and opportunities for boating, fishing, and birdwatching.
- **Andaman and Nicobar Islands**: These islands are a paradise for nature lovers, as they boast of rich biodiversity, coral reefs, mangroves, and marine wildlife. They also offer adventure activities like scuba diving, snorkeling, and surfing.
- **Lakshadweep Islands:** These islands are located in the Arabian Sea and are known for their pristine beaches, turquoise waters, and coral atolls. They are ideal for relaxing, swimming, and exploring marine life.

Blue Flag Certification

Blue flag certification is a globally recognized eco-label awarded to beaches, marinas, and sustainable boat tourism operators that meet some prescribed requirements. It is given by the Foundation for Environmental Education (FEE), a non-profit organization based in Denmark.

Requirements for Blue Flag Certification:

- High standards of water quality, environmental management, safety, and services.
- Compliance with local, national, and international regulations and laws.
- Provision of environmental education and information to the public and visitors.
- Promotion of sustainable development and conservation of coastal and marine ecosystems.

Blue flag certification provides insight into the health of the coastal ecosystem and encourages responsible tourism and recreation. It also helps to raise awareness and appreciation of the natural environment among the local communities and visitors.

As of 2023, India has 12 blue flag certified beaches, which are among the cleanest and most beautiful in the country.

Benefits of Blue Flag Certification:

- It indicates that the water quality, environmental management, safety, and services of the certified sites are of high standards.
- It attracts more tourists who are looking for a higher level of environmental responsibility and cleanliness.
- It enhances the livelihood and income prospects of the local communities who depend on tourism.
- It raises awareness and appreciation of the natural environment among the visitors and the locals.
- It supports the conservation and sustainable development of the coastal and marine ecosystems.

Sustainable Tourism

Sustainable tourism is defined by the UN Environment Program (UNEP) and the UN World Tourism Organization (UNWTO) as "tourism that takes full account of its current and future economic, social, and environmental impacts, addressing the needs of visitors, the industry, the environment, and host communities."

Principle of Sustainable Tourism

Fig 10.23: **Principle of Tourism**

Ecotourism and Sustainable Tourism

The difference between ecotourism and sustainable tourism lies in their focus and scope. Ecotourism is a niche segment of tourism that specifically pertains to activities conducted in natural areas. On the other hand, sustainable tourism is not limited to any particular type of tourism; instead, it represents the overarching goal for all forms of tourism to have sustainable impacts that can endure for generations to come.

Key Principles of Sustainable Tourism

Sustainable tourism, as outlined in the **National Strategy for Sustainable Development**, is guided by three key principles:

- **Environmental Sustainability:** It's about using nature wisely, preserving vital ecological processes, and safeguarding natural heritage and biodiversity.
  - For instance, a hotel in a tourist spot uses solar panels on its roof to generate electricity. This helps them use cleaner energy and lessens their impact on the environment. It also attracts guests who care about eco-friendly options, making tourism more sustainable.
- **Socio-cultural Sustainability:** This means respecting the culture and traditions of local communities, promoting intercultural understanding, and preserving their heritage.
  - For example, a tour company could partner with the Warli tribal community in Maharashtra to showcase their traditional **Warli art and culture.** Visitors would have the opportunity to participate in workshops, interact with Warli artists, and learn about their way of life. This collaboration ensures the preservation of this unique cultural heritage while also creating income opportunities for the tribal community.
- **Economic Sustainability:** It aims to create long-lasting economic benefits, providing stable jobs, income opportunities, and social services for local communities while helping reduce poverty. For example, in Bhutan's tourism industry, there exists a notable instance of economic sustainability known as the "**Community-Based Sustainable Tourism (CBST)" program**.
  - This initiative actively involves local communities in tourism activities while concurrently preserving their culture and environment. One specific program under CBST, the "Homestay in Sakteng," enables tourists to reside with local families, generating additional income for households in remote regions. This not only offers economic benefits to the local populace but also plays a crucial role in preserving their traditional way of life and protecting the environment, ultimately contributing to long-term economic sustainability.

Role of Sustainable Tourism in India

- **Climate Change Mitigation**: India has set an ambitious target to reduce its carbon emissions by a massive one billion metric tons by 2030. Now, when we look at tourism, it's responsible for a significant chunk of the **world's carbon emissions—around 8%.** So, if sustainable tourism practices, like conserving resources adopted, we can make a big dent in that 8%.
  - Additionally, by investing in clean and green energy sources for tourism, we can help reduce harmful greenhouse gases, fight climate change, and contribute to innovative energy solutions in cities, towns, and even remote areas. This way, tourism can play a crucial role in protecting our planet and achieving India's emissions reduction goals.
- **Employment**: Ecotourism plays a vital role in generating employment and fostering economic growth while preserving natural and cultural resources. It provides opportunities for enterprise development and job creation, even in remote communities, thereby supporting local services and businesses.
  - Attracting tourists to rural areas through sustainable tourism models helps alleviate issues like disguised unemployment in agriculture and urban migration. Moreover, it promotes intercultural understanding and peace, further enhancing its significance in sustainable livelihoods. The Ministry of Tourism recognizes the potential of ecotourism in this context and actively promotes it under the 'Incredible India' brand.
- **Preserving Cultural Heritage:** When done correctly, creating a sustainable tourism economy is a wonderful way for residents in any region to preserve their cultural heritage and offer educational experiences to visitors. One of the most effective ways tourism can safeguard cultural heritage is by empowering the community.

- This happens when tourists learn about the local community's history and traditions, which, in turn, fosters a stronger sense of unity and pride within that community regarding its cultural heritage. India, with its rich and diverse cultural heritage and 42 World Heritage Sites, 34 of which are of cultural significance, stands to gain significantly from sustainable tourism practices.

Importance of Tourism In India

- **Economic Growth and Job Creation:** Tourism catalyses economic growth in India by creating income opportunities and jobs. In 2021, it contributed ₹13.2 lakh crore, equivalent to 5.8% of India's GDP, and supported 32.1 million jobs, significantly contributing to poverty alleviation and fostering sustainable human development.
- **Foreign Exchange Earnings:** Tourism is a vital source of foreign exchange earnings for India, positively impacting the country's balance of payments. In 2022, India earned ₹1,34,543 crore in foreign exchange revenue through tourism.
- **Conservation of Cultural Heritage and Natural Environment:** The tourism sector assumes a vital responsibility in the protection and preservation of both cultural and natural heritage sites. This includes the safeguarding of renowned landmarks like the Taj Mahal, and the Ajanta and Ellora temples, which owe their preservation to the diligent efforts of the Tourism Department. Furthermore, tourism plays a significant role in the preservation of natural habitats that are home to endangered species.
- **Fostering Peace and Stability:** The tourism sector holds the potential to encourage peace and stability in countries undergoing development, such as India. This potential is realized through the creation of jobs, income-generating opportunities, economic diversification, environmental protection, and the promotion of mutual understanding among different cultures.
- **Infrastructural Development**: Nowadays, it is ensured that Travelers do not face any problems; multiple-use infrastructures are being developed at several tourist places. Uttarakhand's plan to start mobile caravans is the latest example.

Scope of Tourism in India

- **Abundant Workforce:** India boasts a plentiful labour force, particularly in the hospitality sector, making it exceptionally suitable for tourism. This labour availability is a significant advantage, as the tourism industry relies heavily on a skilled and dedicated workforce.
- **Incredible Diversity:** India's rich tapestry of culture, geography, languages, and natural beauty makes it a captivating destination. From the towering Himalayas in the north to the lush plains of Punjab, the rolling hills of Assam in the east, and the tropical coastlines in the south, each state in India offers a distinct and unique experience to the world.
- **Foreign Investment Opportunities:** India has opened its doors to foreign investment, allowing **100% FDI (Foreign Direct Investment) in the tourism sector.** As a result, India's tourism and hospitality industry is poised for remarkable growth.
  - Projections indicate that by 2028, the industry will generate $50.9 billion in Visitor Exports, a significant increase from $28.9 billion in 2018. Furthermore, Foreign Tourist Arrivals (FTAs) are expected to reach 30.5 million by 2028. This indicates a promising future for India's tourism sector, with the potential for substantial expansion.
- **New Tourism Attractions**: In India, the tourism industry is diversifying away from traditional sightseeing tours (primarily places of cultural tourism interest) to a more rapidly expanding market based on the country's atmosphere and environment, emphasizing the aesthetic, environmental, and socio-cultural implications of projects.

In essence, India's tourism sector is primed for substantial growth, thanks to its abundant workforce, diverse attractions, and favourable foreign investment policies. This sector's future appears bright and promising, making it an exciting prospect for both domestic and international stakeholders.

Challenges in Indian Tourism Sector

- **Infrastructure Development:** While India is continually improving infrastructure like airports, highways, and public transportation at tourist destinations, it often falls short and remains outdated.
  - This affects not only domestic tourists but also foreign visitors. India's aviation industry, along with its burgeoning tourism sector, faces a significant infrastructure challenge. To accommodate an additional 500-600 million passengers by 2030, the country will need to construct 55 new airports, which collectively require a vast expanse of 150,000 to 200,000 acres of land.
  - The urgency to address this issue underscores the critical need for India to enhance its infrastructure to meet the growing demands of the aviation and tourism sectors.
- **Environmental Sustainability:** Increasing tourist footfalls often leads to environmental degradation at popular tourist spots. The **National Disaster Management Authority (NDMA)** in a 2020 report recognized that the Indian Himalayan Region faces significant challenges in dealing with climate change effects and acknowledged that towns and some mountainous villages are struggling due to the pressures of tourism growth and rural-to-urban migration.

- In 2022, Uttarakhand alone saw a staggering 100 million tourists, including pilgrims, visiting the region. Experts have warned about the dangers of unregulated tourism that exceeds the area's ecological carrying capacity, which refers to the maximum rate of resource usage and waste discharge that can be sustained for economic development.
- The recent Joshimath land crisis serves as a vivid illustration of the repercussions arising from unsustainable tourism practices.

❑ **Safety and Security:** Ensuring the safety and security of tourists is critical. This involves addressing issues such as crime, and harassment, and improving emergency response systems.
- While crimes against foreigners have decreased in India, even a single incident can harm the country's image. Reported criminal acts against foreign nationals decreased from 404 in 2019 to 150 in 2021 according to NCRB data.

❑ **Promoting Responsible Tourism:** Encouraging responsible tourism practices is vital. This means respecting local cultures, traditions, and natural environments while minimizing negative impacts.
- This approach can make local communities more welcoming to tourists and help explore the unique culture and art of even small Indian villages.

❑ **Skill Development:** Developing a skilled workforce is a challenge in the tourism sector, much like in other industries. Despite having one of the world's largest youth populations, India lacks an adequately trained workforce for tourism.
- The hospitality industry faces a significant demand-supply gap, with over 60 per cent unfilled positions.
- Skills required for the Indian tourism workforce include excellent customer service, effective communication (including foreign languages), cultural sensitivity, and hospitality skills.
- Adaptability to changing situations, networking capabilities, and leadership skills are valued traits in the industry, ensuring a memorable and responsible tourism experience for visitors.

These challenges in the Indian tourism sector, including infrastructure, environmental sustainability, safety, responsible tourism, and skill development, require attention and solutions to promote sustainable and thriving tourism in the country.

IGNITE YOUR MIND

Silence of the Servers: Communication networks fall silent, plunging a tourist hotspot into darkness. Is it a criminal act, an act of war, or a mere technical glitch? Can legal frameworks effectively address security threats in complex, interconnected communication systems vital for tourism and order?

NATIONAL TOURISM POLICY 2022

The latest draft of the national tourism policy was released by the Ministry of Tourism in 2022. The policy proposes five broad missions for the Indian tourism sector:

❑ **National Green Tourism Mission:** To promote sustainable and responsible tourism practices that conserve the natural and cultural heritage of India, and to mitigate the adverse impacts of tourism on the environment and society.

❑ **National Digital Tourism Mission:** To leverage the potential of digital technologies and platforms to enhance the quality, accessibility, and affordability of tourism services and products, and to create a seamless and integrated tourism ecosystem.

❑ **National Mission for Tourism Skilling:** To develop and upgrade the skills and competencies of the tourism workforce, and to create employment and entrepreneurship opportunities for the youth, women, and marginalized sections of the society.

❑ **National Mission for Destination Management:** To improve the infrastructure, amenities, and governance of the tourist destinations, and to ensure their safety, security, and cleanliness.

❑ **National Mission for Tourism SMEs:** To support and facilitate the growth and innovation of the small and medium enterprises in the tourism sector, and to provide them with financial, technical, and marketing assistance.

The policy is expected to boost the tourism industry in India, which contributes to about 6.8% of the GDP and provides employment to about 87.5 million people. **The policy also aims to increase India's share of the global tourist arrivals from 0.64% in 2019 to 1% by 2024 and 2% by 2030.**

The 7-S Mantra that guide the implementation of the tourism policy:

❑ **Swaagat (Welcome):** To create a hospitable and friendly environment for the tourists, and to showcase the rich and diverse culture of India.

❑ **Soochana (Information):** To provide accurate, timely, and user-friendly information to the tourists, and to use digital platforms and technologies to enhance the accessibility and dissemination of information.

❑ **Suvidhaa (Facilitation):** To facilitate the travel and stay of the tourists, and to provide them with quality and affordable services and products.

❑ **Surakshaa (Security):** To ensure the safety and security of the tourists, and to protect them from any threats or risks.

❑ **Sahyog (Cooperation):** To foster cooperation and coordination among various stakeholders, such as the central and state governments, the private sector, the civil society, and the local communities, and to promote public-private partnerships for tourism development.

- **Sanrachna (Infrastructure):** To develop and improve the infrastructure and amenities of the tourist destinations, and to provide them with adequate connectivity, accessibility, and mobility.
- **Safaai (Cleanliness):** To maintain the cleanliness and hygiene of the tourist destinations, and to adopt sustainable and responsible tourism practices that preserve the natural and cultural heritage of India.

The 7-S Mantra is inspired by the vision of 'Atithi Devo Bhava', which means 'the guest is equivalent to God'. The mantra aims to create a memorable and satisfying experience for the tourists, and to enhance the image and reputation of India as a tourism destination.

Major Government Initiatives

- **Incredible India 2.0 Campaign (2017):** The Ministry of Tourism has launched the "Incredible India 2.0" Campaign, shifting from generic worldwide promotions to targeted marketing and content creation. This campaign focuses on key source markets for Indian tourism and emerging markets with great potential.
- **Swadesh Darshan Scheme (2015):** This is the Ministry of Tourism's flagship "Swadesh Darshan" scheme that provides financial support to states, UTs, and central agencies for tourism infrastructure development.
  - Aim to create special tourist circuits in our country, based on specific themes. These routes will focus on providing great experiences for tourists, being attractive to visitors, and making sure they last for a long time.
  - This project is fully funded by the central government.
  - The Ministry has now revamped the scheme as SD2.0 with a focus on sustainable and responsible destination development with a tourist-centric approach.
- **PRASAD Scheme(2014-2015):** The "Pilgrimage Rejuvenation And Spiritual Augmentation Drive" (PRASAD) scheme, launched in 2014-2015, aims to develop pilgrimage sites across India for an enhanced religious tourism experience.
  - It seeks to integrate pilgrimage destinations systematically to offer a complete religious tourism experience, recognizing the significant role of pilgrimage tourism in domestic tourism growth.
- **Adopt a Heritage- "Apni Dharohar, Apni Pehchaan" Project(2017):** The project involves entrusting the development, construction, and maintenance of heritage sites, monuments, and tourist sites to private and public sector entities, known as Monument Mitras ensuring they adhere to relevant guidelines.
  - The **"Adopt a Heritage 2.0"** program aims to improve the maintenance and revitalization of India's culturally rich heritage, aligning with the vision of 'Virasat Bhi, Vikas Bhi.'
  - This program aims to encourage collaboration with corporate stakeholders, allowing them to contribute to the preservation of these monuments for future generations.
  - Under this program, the ASI (Archaeological Survey of India) invites corporate stakeholders to enhance the amenities at these monuments by utilizing their CSR (Corporate Social Responsibility) funds.
- **National Digital Tourism Mission (NDTM)(2020-2021):** It is a digital initiative launched by the Ministry of Tourism to facilitate information exchange and service delivery among the stakeholders of the tourism ecosystem, such as tourists, service providers, destinations, products, experiences, and authorities.
  - The mission aims to create a unified tourism interface for the country, where there are opportunities for seamless and secure data sharing, interoperability, innovation, and collaboration.
- **NIDHI Portal:** It is a portal for the National Integrated Database of Hospitality Industry, which collects and maintains data on hotels, restaurants, and other tourism service providers in India.
  - The portal enables the service providers to register, update, and verify their information, as well as access various benefits and schemes offered by the government and other agencies.
  - The portal also allows the tourists to provide feedback and grievances, as well as access live darshan, events, and festivals across the country.
- **Utsav Portal:** It is a portal for showcasing the events and festivals in India, as well as live streaming from various places of pilgrimage. The portal is a joint initiative of the Ministry of Tourism and the United Nations Environment Program (UNEP) India, with the support of the Responsible Tourism Society of India (RTSOI).
  - The portal aims to promote the rich and diverse culture and heritage of India, as well as encourage responsible and sustainable tourism practices.
- **National Strategy for Sustainable Tourism(2022):** It is a comprehensive document that outlines the vision, mission, objectives, and action plan for developing and promoting sustainable and responsible tourism in India.
  - The strategy document covers various aspects of tourism development and management, such as environmental, economic, social, cultural, and governance dimensions.
  - The strategy document also aligns with the Sustainable Development Goals (SDGs) and the global best practices in the tourism sector.
- **Responsible Traveller Campaign:** It is a campaign to raise awareness and educate the travellers on how they can contribute to the sustainability and responsibility of tourism in India. The campaign is a joint effort of the Ministry of Tourism, the UNEP India, and the Responsible Tourism Society of India (RTSOI).

- The campaign involves the dissemination of guidelines, videos, posters, and other materials on various platforms, featuring celebrities, industry experts, and influencers.
- The campaign also encourages the travellers to adopt the 'reduce, reuse, recycle' approach, respect the local culture and environment, and avoid unethical and illegal activities.

Announcements for tourism sector in Budget 2024: The tourism sector in India received a boost in the Interim Budget 2024 to make India a global tourism hub. Some of the key announcements for the tourism sector are:

- A 44.7% increase in the allocation for the tourism ministry, from ₹1,692.10 crore in 2023 to ₹2,449.62 crore in 2024.
- A plan to encourage states to undertake development of iconic tourist centres, including spiritual tourist spots, to attract business and promote local entrepreneurship.
- A focus on developing port connectivity, tourism infrastructure, and amenities on islands, especially Lakshadweep.
- A provision of long-term interest free loans to states for tourism-related development.
- A capital expenditure of ₹85,000 crore to be spent on 72 new greenfield airports.

Hospitality Sector

The hospitality sector in India is a booming industry that offers various services and opportunities to tourists, travelers, and businesses. According to a report, the hospitality market in India is expected to grow at a CAGR of 4.73% from 2024 to 2029, reaching USD 31.01 billion by 2029.

Some of the factors that contribute to this growth are

- India's rich culture and diversity, which attract global guests and promote spiritual tourism.
- The rise of domestic travel, driven by the growing middle class, increased disposable income, and the interest of millennials to explore their own country.
- The innovation and expansion of accommodation options, such as Airbnb, Oyo rooms, and international hotel chains, which offer cost-effective and flexible stays in prime locations.
- The government's efforts to boost tourism infrastructure, ease of doing business, and foreign direct investment, as well as developing ports as cruise tourism hubs.

The hospitality sector in India is also a major source of employment, accounting for more than 8% of the country's workforce and creating an estimated 15 million jobs in the last few years.

Way Forward

- **Improving the infrastructure and facilities**: India needs to invest more in developing and maintaining its physical, social, and digital infrastructure, such as roads, railways, airports, hotels, hospitals, internet, etc. This will enhance the accessibility, comfort, and safety of the tourists and improve their satisfaction.
- **Enhancing the human resources and planning**: India needs to train and skill its workforce in the tourism and hospitality industry, and provide them with better incentives and working conditions. This will improve the quality and professionalism of the service and customer care. India also needs to have a clear and coordinated vision and strategy for tourism development, involving all the relevant stakeholders and agencies.
- **Increasing the digital promotion and marketing**: India needs to leverage the power and reach of digital platforms, such as social media, websites, apps, etc., to promote and market its tourism products and potential. This will increase its visibility and attractiveness among the potential tourists, both domestic and international.
  - India also needs to create a strong and positive brand image and identity for its tourism sector, highlighting its uniqueness and diversity.
- **Reducing the taxation issues**: India needs to rationalize and harmonize its tax regime and policies for the tourism sector, and make it more competitive and affordable compared to other destinations.
  - This will boost the demand and revenue for the tourism sector, and also encourage more investment and innovation.
- **Ensuring the security and safety**: India needs to address the various security threats and challenges, such as violence, crime, and health risks, that deter tourists from visiting the country.
  - This will require strengthening the law and order, intelligence, and emergency response systems, as well as enhancing the awareness and preparedness of the tourists and the industry.

CONCLUSION

The tourism sector in India intricately intertwines threads of history, culture, and natural beauty, forming a vibrant tapestry. As the nation progresses, its ability to charm travelers also advances. Through focused initiatives to overcome obstacles and seize opportunities, India's tourism industry is positioned for sustained growth, promising an ever-more enriching adventure for those exploring its myriad wonders.

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